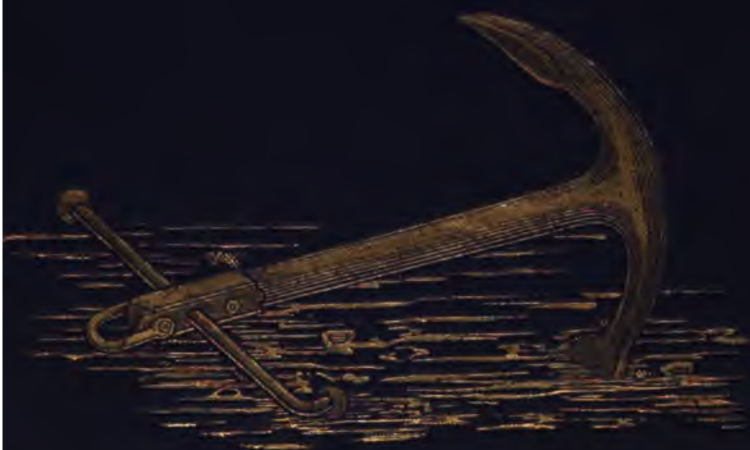

THE BRITISH NAVY.

VOL. III.

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THE BRITISH NAVY:

ITS STRENGTH, RESOURCES, AND ADMINISTRATION.

BY

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AND 'BRITISH SEAMEN.'

VOLUME III.

PART III.

OPINIONS ON THE SHIPBUILDING POLICY OF THE NAVY.

Monstrum horrendum, informe, ingens, cui lumen ademptum.

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CONTENTS

OF

THE THIRD VOLUME.

PART III.

OPINIONS ON THE SHIPBUILDING POLICY OF THE NAVY.

INTRODUCTION.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION I.

DIMENSIONS.

SECTION II.

SPECIALISATION OF TYPES.

SECTION III.

ARMOUR.

SECTION IV.

TURRET SHIPS AND MONITORS.

SECTION V.

ARMAMENTS.

SECTION VI.

THE RAM AS A NAVAL WEAPON.

SECTION VII.

TORPEDOES AND TORPEDO VESSELS.

SECTION VIII.

THE 'POPOFFKA' TYPE.

SECTION IX.

MISCELLANEOUS.

SECTION X.

SECTION XI.

PAPERS AND PARLIAMENTARY SPEECHES BY COMPILER ON DESIGNS FOR SHIPS OF WAR.

PART III.

OPINIONS ON THE SHIPBUILDING POLICY OF THE NAVY.

INTRODUCTION.

AMONG the many problems of naval administration, the most difficult by far is the policy to be adopted in relation to shipbuilding. The strength to be maintained cannot be determined by any absolute standard. It depends on the state of preparation and the nature and degree of activity with which shipbuilding operations are being carried on by other Powers, now our friendly rivals, but with whom we may hereafter be in conflict. Difficulty of framing a shipbuilding policy.

The type and the dimensions of the ships which it is expedient to construct for the immediate reinforcement of the navy must necessarily be determined with reference to the naval operations for which the ships are to be designed. For our own country it is of vital importance to keep open the communications across the ocean with our foreign and colonial dependencies, and the external sources of our food supply. Our navy cannot be chiefly or mainly a defending force. In order to maintain the command of the seas, we require sea-going and sea-keeping ships. It is to these, and not to harbour defence ships, that our shipbuilding operations should be mainly directed. To use the language of a communication addressed by Mr. Lenthal, the Chief Constructor, and Mr. Isherwood, the Engineer-in-Chief of the American navy, to the Naval Department in March, 1862:—'Harbour defences are indeed valuable adjuncts and should not be neglected, but they cannot constitute a navy, or perform its proper functions. If ever assailed by a powerful maritime foe, we shall find how much better it is to fight at the threshold than at the hearthstone.' Types required. Lenthal and Isherwood.

Captain Colomb, in the naval prize essay of 1878, expressed himself on the same subject as follows:— Captain Colomb, R.N.

'The building of powerful ships, which are not fully sea-going, can only be justified on the assumption that the chief danger lies at the heart of the Empire, and not on our lines of communication.'

A regular supply of fuel is the main difficulty with a steam navy.

rbour fence ips not primary cessity.

In this regard Great Britain possesses overwhelming advantages in her connected series of coaling stations along the main routes of trade. Our foreign naval stations should be protected against a *coup de main* by local means, which need not be less effectual because inexpensive. By timely care the necessity for a lavish outlay may be averted. A few well-placed earthworks, a local force of artillerymen, the men who coal the ships being trained to assist at the guns, and a supply of torpedoes are indispensable; and when these are provided the main duty of the navy will be, not to remain in or off the harbours, which form the bases of our naval operations, but to blockade the enemy in his own ports, and cruise at sea in search of any squadrons which may have set forth to attack our colonies or to interrupt our communications. Smaller vessels are needed, as will be hereafter shown, as auxiliaries to the powerful ships on which our efforts should be mainly concentrated: but the fighting fleet should be adapted primarily for the time of battle. No success in secondary enterprises can be set in the balance against defeat in the decisive struggles. The minor advantages gained by the French, in seas remote from the principal theatre of war, afforded them no compensation for the defeats they sustained at Aboukir and Trafalgar.

rien de Gra- ère, Marine Aujour- hui,' p. xiv.

The arguments in support of the policy of devoting our main resources to ships for the line of battle were set forth with his usual force and clearness by Admiral Jurien de la Gravière in the fourteenth chapter of his Essay, 'La Marine d'Aujourd'hui.' 'Dans le plan adopté en 1857, il y eut, à mon sens, en même temps qu'une idée juste, deux idées fausses.

'La première attribue à la marine pour rôle principal le transport d'une armée sur le littoral ennemi, tandis que c'est l'occupation de la route maritime qui est le point essentiel. La sécurité du trajet garantie, les flottes marchandes suffiront pour l'accomplir.

'A quoi peut servir une marine? C'est la première question qu'un budget, et surtout un budget dans l'embarras, doit se poser. Je réponds sans hésiter: à occuper les grandes voies maritimes. L'occupation de la mer, ne fût-elle que temporaire, doit avoir, même dans une guerre continentale, des conséquences de la plus haute portée. C'est par là que les Etats du Nord en Amérique ont triomphé de la résistance des Etats du Sud; c'est par là qu'en Europe l'Angleterre a fini par user le premier empire; c'est par là qu'en Crimée nous avons vaincu la Russie. On a beaucoup exagéré le dommage causé au commerce américain par quelques corsaires; on a fait un bruit ridicule de la capture d'un navire de commerce

français par une corvette allemande s'échappant, au cœur de l'hiver, d'un port inaccessible qui n'était plus bloqué. La suprématie navale la mieux établie ne saurait prévenir complétement ces déprédations. Sur mer aussi bien que sur terre, une armée victorieuse n'a pas de convois qui ne puissent être inquiétés; mais quels résultats peuvent avoir de pareils coups d'épingle? S'imagine-t-on que les prouesses de vingt "Alabamas" auraient pu retarder d'un jour la prise de Richmond? Si c'est sur de tels souvenirs qu'on s'appuie pour nous recommander la guerre de course et pour réclamer le licenciement de nos escadres, je demanderai de mon côté qu'on veuille bien se placer un instant en face de l'hypothèse suivante.—Les armées de la France sont de nouveau rangées sur les bords du Rhin, les mers sont en tous sens sillonnées pas nos frégates et par nos corvettes; mais une flotte allemande croise devant nos ports, et nous n'avons pas de flotte à lui opposer.—Quelles seront les suites de cet état de choses? Toutes nos côtes seront tenues en alarme, tous nos ports demanderont des garnisons, toute notre population maritime sera exposée à tomber aux mains de l'ennemi. C'est le destin fatal des équipages de corsaires de terminer leur carrière aventureuse sur les pontons, et par corsaires j'entends les navires de guerre armés pour la course aussi bien que les écumeurs de mer équipés par la spéculation privée. Dans la guerre de 1778, on a vu nos croiseurs isolés succomber l'un après l'autre le jour où l'Océan a été momentanément abandonné aux escadres anglaises. C'est qu'il faut en effet considérer les escadres comme autant de places fortes mobiles d'où sortent avec une sécurité relative les colonnes volantes qui vont battre le pays aux alentours. Avant d'écumer les mers, je suis d'avis qu'il les faut balayer. Tant que le balai de Tromp restait arboré au grand mât de son vaisseau, les marchands d'Amsterdam et de Flessingue étaient tranquilles. Ils savaient que leurs pertes, s'ils en subissaient, seraient légères.'

Admiral Porter, in one of his able annual reports, fully concurs in the views of Admiral de la Gravière. 'No matter how many wooden vessels with fair batteries we may possess, they add nothing to our fighting force. They are vulnerable at all points, and are in danger equally from shots entering their boilers and their powder magazines. Formidable as were frigates a few years ago as despatch vessels, to cut up commerce and overcome heavy privateers, any engagements they fought on the ocean did not materially affect the result of the war. The power of a navy was in its ships of the line, and not in its smaller vessels. Accepting these views, it will be our policy to con- Admiral Porter, U.S.N.

centrate our main efforts on first-class battle-ships. They should be supported, as it has been shown, by numerous auxiliaries.

islère.

The arguments against the second-class armoured cruisers were summed up by M. Dislère in the opening of the fourth chapter of 'La Guerre d'Escadre.' His observations confirm what we have already endeavoured to urge on the importance of the principle of specialisation in the designs for ships of war:—

'Les cuirassés de seconde classe, destinés particulièrement aux stations lointaines, doivent, au besoin, servir d'auxiliaires dans les escadres composées de cuirassés de première classe: telle est du moins la définition officielle des cuirassés de station, devant, par suite, croiser, combattre au loin des batteries de côte, enfin prendre place dans une ligne de bataille; mais, de cette définition même doit découler un type forcément imparfait, dans lequel on ne peut réunir ce qu'on appelle les *desiderata* du navire cuirassé. A quelque point de vue qu'on se place, on est amené à reconnaître la presque impossibilité de réaliser ce programme dans de bonnes conditions; en effet, s'il s'agit de la guerre d'escadre, ces navires n'auront pas une artillerie suffisante pour ouvrir le feu d'une manière efficace, alors que les pièces de leurs adversaires commenceront déjà à les atteindre utilement; leur masse serait, il est vrai, bien suffisante pour infliger, dans un combat par le choc, un désastre irrémédiable aux plus puissants cuirassés ennemis, mais la vitesse leur manquera pour les atteindre;—s'il s'agit de la guerre des côtes, ils ont trop de tirant d'eau, et leur cuirasse, naturellement d'épaisseur limitée, ne les protége pas contre les batteries de terre;—s'il s'agit enfin de la guerre de course, leur vitesse est trop faible et leur cercle d'action trop restreint. C'est que, en effet, s'il n'est guère possible de faire un navire à deux fins, il l'est moins encore de le construire de manière à répondre à trois sortes d'exigences s'excluant mutuellement: on n'arrivera qu'à un seul résultat, ne satisfaire à aucune d'entre elles.

'On peut d'ailleurs trouver la preuve de ce fait dans les essais nombreux tentés en France depuis l'adoption du nouveau programme de la flotte, sans parvenir à établir un plan qui puisse être pleinement adopté. Au début, on supposait que des navires de ce type ne coûteraient pas plus de 4 millions, qu'ils auraient, par suite, un déplacement de 4,000 tonneaux environ; dès qu'on a voulu faire un programme, il a fallu porter ce chiffre à 4,700 tonneaux, et les derniers programmes sur lesquels on cherche une solution atteignent un déplacement de 5,700 tonneaux: on est cependant encore au-dessous des 7,400 tonneaux cuirassés anglais de cette classe, le "Nelson" et le "Northampton."

'L'Amirauté, après avoir renoncé pendant longtemps à construire des navires de ce type, en a successivement fait mettre trois en chantier; c'est que, en effet (et c'est le seul motif à faire valoir en faveur de l'existence de ces navires), ils peuvent être utiles au point de vue politique. A tort ou à raison, ils imposent par leur présence, et les plaques de cuirasse produisent un effet moral que l'on chercherait en vain à nier. Mais cette raison est-elle suffisante pour qu'on lui sacrifie les autres qualités du navire? peut-elle motiver une dépense de 6 à 7 millions pour chaque unité de cette flotte spéciale? Pour répondre à cette question, il est nécessaire de passer successivement en revue les divers navires de ce type construits dans les dernières années et de chercher, d'une part, si réellement ils ont une puissance défensive suffisante pour que leurs plaques leur assurent cette influence morale que l'on recherche; de l'autre, à quel prix ce résultat a pu être atteint.'

Our efforts should be directed mainly to first-class battle ships and their auxiliaries.

For ourselves it seems quite unnecessary to introduce many armoured cruisers into the ship-building programme. A limited number will be necessary with a speed of not less than 16 knots for the protection of commerce. The older ironclads, originally designed for European service, are falling only too rapidly out of date for the line of battle. They may still render excellent service against fleets which contain no vessels of the great power and cost which distinguish the most recent additions to European navies. The armoured vessels of the United States were designed for coast service. The latest additions to the Brazilian and Argentine navies are vessels adapted to inland navigation. The sea-going ironclads of Chili and Japan are ships of the second class. In the China Sea, on the west coast of South America, in every harbour remote from Europe, our flag will be shown with credit for years to come in ironclads, condemned as obsolete for a commission in the Channel and Mediterranean.

The ship-building for the British navy must be comprehensive.

While insisting that our ships should be essentially sea-going and sea-keeping, it is neither necessary, nor indeed desirable, that all should be of a type specially designed for extended cruises on the ocean. All our ships should be capable of making passages from port to port, but some must be of moderate draught and handy in narrow waters; and, in order to secure these qualities, the features that constitute what has been called habitability in an ocean-going vessel must be modified and partly surrendered. A great navy like that of England can only be rendered complete by an eclectic and comprehensive policy. We must not rely exclusively on the turret or the broadside, on monster guns or light armaments, on torpedoes or on rams; but every naval weapon and every class of fighting ship

must be included in due proportion in our programme of construction.

Admiral Touchard.

The following remarks occur in a paper on coast defence, published by Admiral Touchard in the *Revue Maritime* in **February**, 1877. They are quoted in order to show the diversity of types required to complete a fleet, even when the operations in contemplation are confined to European waters:—

'We have seen Italy, Germany, and Russia take part in the combinations of naval war. What would be the relative weights which these new Powers would throw into the scale? That is indeed an impenetrable secret, and we shall not attempt to utter prophecies on the uncertainties of the future. But we can already foresee, distinctly, that the scene of great naval battles will be changed. We shall no longer be called upon to fight our ancient rivals on the coasts of India and China, or to sustain the independence of America. The chief scene of the struggles of the future—God grant that contests so terrible may be far distant!—will be the seas of Europe. In such a war coast operations will become in the highest degree important. Having command of the seas, you may take the offensive on the shores of the enemy. If beaten, and reduced to the defensive, you will have to defend your own coasts.

'Ironclad ocean-going vessels are not adapted to coast warfare. All the chief naval Powers, however, will possess a fleet of ocean-going ships,—indeed, they have such fleets already, and all will desire to fight for the command of the seas in those European waters, which will become the arena for great naval battles. Operations therefore will begin with encounters between ocean-going ships; and the conqueror in a general engagement, secure from attack on his own shores, will be able to employ his coast-defence fleet to the best advantage. The fleet, therefore, which is designed for coast-operations, must be composed of vessels of two distinct types, the one consisting of gunboats, or floating gun-carriages, intended simply for local harbour defence; the other type, intended to operate in European waters as well as on the coast, will include armoured coast-defence vessels and torpedo-boats. Vessels of this class will take an active part in co-operating with the fleets of sea-going ships.'

Diversity of view as to best types.

It is easy to secure a concurrence of naval opinion that the fleet of England should be strengthened with the best ships of all classes. Unanimity ceases when we come to consider the relative proportions in which our expenditure shall be apportioned, as between the several types of ships required for the navy.

It will throw some light on our path, if we look abroad, and see what ships are being built in foreign dockyards. The following list is believed to be sufficiently accurate and comprehensive :— Ships building in foreign dockyards in 1880.

	Type	Displacement	Armament	Speed
France.			Guns	Knots
Amiral Duperré	Broadside, 4 barbette turrets	10,320	4 46 tons 13 53 cwt.	14
Amiral Baudin Formidable	Broadside, 3 barbette turrets	11,156	3 100 tons 12 53 cwt.	14?
Vauban Duguesclin	Broadside, 4 barbette turrets	5,800	4 15½ tons 1 7½ tons 6 53 cwt.	14·5
Bayard Turenne	Broadside, 4 barbette turrets	5,000	4 15½ tons 1 7½ tons 6 53 cwt.	
Foudroyant. Dévastation.	Broadside, 2 barbette turrets	9,630	4 46 tons 2 27½ tons 8 53 cwt.	
Coast Defence.				
Caïman Indomptable Requin Terrible	2 revolving turrets	7,109	2 72 tons	14
Fulminant Furieux	1 revolving turret	5,495	2 27½ tons	13·8
Tonnerre Vengeur Tonnant Tempête	1 revolving turret	4,452	2 27½ tons 2 46 tons	10
Italy.				
Italia Lepanto	Citadel ship, 2 turrets	13,700	4 100 tons 18 6 inch	16
Duilio Dandolo	Citadel, 2 turrets	10,650	4 100 tons 4 small	14
Germany.				
1 Sachsen type	Citadel, turret ship, unarmoured ends	7,290	6 22½ tons	12·0
Coast Defence.				
6 Biene type	1 turret	1,100	1 36 tons	9·0

The latest addition to the Austrian navy is the 'Tegethoff,' a central battery ship of 7,390 tons, protected by 14-inch armour, with a single screw, steaming 14 knots, and armed with six 11-inch, or 18½-ton Krupp guns.

The latest addition to the Danish navy is the 'Helgoland,' in which the central battery is combined with an unarmoured turret. The displacement is 5,347 tons; the armour 12 inches; speed 12 knots; the armament includes one 12-inch 36-ton gun, and four 10-inch or 15½-ton guns of Krupp manufacture.

The growth in the cost and dimensions of ironclad ships has been such, that we may well pause to consider whether we have been pursuing a policy in all respects satisfactory in the recent development of the fleet. Foreign opinion is almost unanimous that the ram must now be recognised as the primary and most deadly weapon of naval warfare. In an engagement with the ram there must be a decisive advantage in numbers. When the crash of the hostile lines has thrown the contending fleets into disarray, the squadron which has the most ships in reserve in the second line of attack will have a splendid opportunity of taking an adversary at a disadvantage in the act of turning. The power of doubling quickly on the enemy is of primary importance in an encounter with the ram; and, *cæteris paribus*, the evolutionary qualities must vary as the relative length. The shorter and smaller ship will have great advantages over the longer and heavier ship both for avoiding the ram and striking an adversary. Speaking of our shipbuilding policy at the United Service Institution, on the 8th June, 1877, Sir Edmund Commerell said: 'There is one point with reference to rams, on which I have a strong opinion that we are going on a wrong tack. If only one-third of the ships of the British Navy are to be furnished with rams, which third ought it to be? My impression is that it ought to be the smaller vessels. Pit a short gunboat like the "Ready" against a long ship like the "Northumberland," and let both stop firing and try ramming. Which of the two vessels would be more likely to ram the other? Why, the short "Ready" gunboat ought to sink the "Northumberland," being much the handier vessel.' It is with these considerations in view, and not for the sake of economy in expenditure, that the limitation of dimensions becomes of paramount importance.

Sir Edmund Commerell, U.S.I., June 8, 1877.

French constructors.

The ablest French constructors are of opinion that all the exigencies of maritime war can be satisfied in ships with a displacement not exceeding 8,500 tons, with a length not exceeding 300 feet, a speed of 14½ knots, carrying two 100-ton and ten 14-centimetre or 52-cwt. guns, and protected by a belt of 22-inch armour, rising three feet four inches above, and descending three feet six inches below the water-line.

Admiral Scott.

Admiral Scott, in his paper on the 'Maritime Defence of England,' produced in 1876, records his views as follows:—

'Our fighting cruisers—ships equally well adapted for single combat or for combined action in line of battle, and able to maintain the honour of the British flag at all times and upon all occasions—should consist, I think, of two classes; the smaller of between 5,000 and

6,000 tons displacement, and the larger of from 7,000 to 8,000 tons, or about the tonnage of the new cruisers "Nelson" and "Northampton," which vessels differ from both the classes I propose, in not being designed to fight with ironclad ships.'

At the close of an article which appeared in the *Rivista Marittima* in June 1880, Signor Cattori sums up his conclusions as follows:— *Rivista Marittima.* Michelangelo Cattori.

I. A combination of the two arms, the gun and the ram, in the same ship would be a much more advantageous arrangement than to have these two arms in two separate ships.

II. A high speed is essentially necessary to meet all the eventualities of a modern naval combat.

III. For Italy the operations of the navy will be limited to the Mediterranean; and a coal endurance of 6,000 miles at a moderate speed would be sufficient for the ships of that country.

IV. For the first-class man-of-war the 43-ton gun might be advantageously substituted for the 100-ton gun.

V. Horizontal armour of eight or twelve inches in thickness, on a vessel subdivided into numerous compartments by watertight bulkheads, might be introduced with advantage as a substitute for vertical armour. The weight saved in the proposed system of armament, as compared with the heavier guns, might with advantage be devoted to a more numerous supplementary armament of guns of from eleven to 25 tons mounted on turntables. The writer is of opinion that a ship fulfilling all the conditions thus laid down can be built with dimensions not exceeding 7,000 or 8,000 tons, and at a cost of from 320,000*l.* to 400,000*l.*

The important object of reduction of dimensions may be secured by limiting the thickness of armour, and by combining guns of moderate with those of the largest calibres. In the Prize Essay for 1878, Captain Colomb ventured beyond the usual vague criticisms, and stated in definite terms the limitations he recommended as to weight of armour and armaments. He said:— Captain Colomb, R.N.

'To me it is as clear as daylight, that the heavy gun will remain, and that the ironclad will remain, but I doubt about the very heavy gun and the very heavy armour. It is impossible on the data available outside the Admiralty, to say exactly whereabouts this medium between the "Inflexible" and the "Gamma" will lie; but as it is necessary for me to assume a medium in terms of English armour and guns, I take it at the 18 to 25-ton gun, and from 10 to 12 inches of the present armour-plating.'

It is not here proposed to reduce dimensions in order to spend less. We are deficient in the number of our ships; and if we spend

a smaller sum on each, we can build more with the same money. It is bad administration to lavish a million sterling, and ten long years, in building a ship which may be destroyed by a torpedo, or sunk by a collision in the Channel. It may indeed be stated as an axiom of shipbuilding policy, that power must be measured in relation to cost of construction. A ship which is twice as strong as another, but costs three times as much, should be looked on as the weaker of the two, as an item of naval policy.

The problem was put in its most practical shape by Captain Custance in the discussion at the United Service Institution, on the Naval Prize Essays of 1878: 'We must therefore consider this: take some given sum of money, say 3,000,000*l.*, what is the best squadron we can make for three millions of money? It is not too much, because the Italians are investing 2,500,000*l.* on four ships. What is the best squadron for 3,000,000*l.*? It will produce six "Inflexibles," or it will produce 120 "Gammas." Now which is most powerful?

'This question has been answered by the Admiralty; they have had to consider whether they would build six "Inflexibles" or a larger number of slightly smaller ships. Instead of going to 11,000 tons, they have taken a displacement of 8,500 tons in the "Ajax," costing 350,000*l.*, which will give them for 3,000,000*l.* nine ships. We therefore have nine "Ajaxes" against six "Inflexibles," nine rams and eighteen pairs of 38-ton guns against six rams and twelve pairs of 80-ton guns. The decision as to which is the best of these squadrons must be left to officers who have commanded fleets. The Admiralty, who have greater experience than anybody else in the country, have decided that the nine rams and eighteen pairs of 38-ton guns are superior to the six rams and the twelve pairs of 80-ton guns. A French constructor, Monsieur Dislère, also places 8,000 tons as the maximum displacement to which it is likely that we shall return.'

Mr. Barnaby has been a consistent advocate for moderate dimensions. He has alluded with regret to the expenditure of nearly a million sterling on the 'Inflexible.' 'The losses and casualties of a naval engagement would do much to bring out the imminence of these risks, and would perhaps show that the large and costly ship is even more exposed to them than the smaller one. It may be that the limit of size and cost has been reached in the 'Fury,' and that, with her bulk and cost, the maximum of advantages may be obtained. We are ourselves disposed to think that this is so, and that there may be retrogression in this respect, as more experience is gained

with the powers of the ram, the torpedo, and other submarine instruments of attack. We should prefer to adhere to this bulk and cost in the new design.'

The late Mr. W. S Lindsay.

The argument against the great dimensions of the most recent ironclads was put very forcibly by Mr. W. S. Lindsay, long an honoured representative of the mercantile marine in the House of Commons, in a paper on 'Our Maritime Defences.'

'Within the last few years we have expended very large sums of money in the creation of huge ironclads or floating citadels, each of which, when fully equipped, costs somewhere about half a million sterling. Some of them are to mount guns of 81 tons weight—unquestionably huge instruments of destruction—but will they be as efficient for the purposes I have named as vessels of greater speed and of only one-quarter their cost? *I doubt it.* Nor do I exclude from my doubts such vessels as the "Inflexible" and "Dreadnought," which are each, I understand, to mount four of these guns on turrets, and to cost, ready for sea, 750,000*l.* A ship costing half a million sterling, and with, what is far more precious, 600 to 700 men on board, might thus be instantaneously destroyed by a torpedo boat costing 4,000*l.* and with less risk to herself than might be supposed. One hundred of these craft, or one thousand Whitehead torpedoes, could be constructed at less cost than we have expended on our last floating citadel. How, indeed, could we order 600 men, for instance, to coop themselves up in a large armour-clad ship, to be drowned like rats, without any chance or hope of defending themselves against the horrible ravages of such an infernal instrument as a torpedo?'

Extreme displacements were originally adopted with the view to carrying armour of sufficient thickness to resist the fire of heavy guns. The guns have gained steadily in power, and armour, which will resist the heaviest armament now carried on board ship, is necessarily concentrated on a very limited area. Other weapons have sprung into existence, less certain, but more deadly and terrible than the gun, and against the locomotive torpedo and the ram, armour offers no protection. The conclusions drawn by Captain Fisher, in his observations on the recent experiments with Whitehead torpedoes in 1879 and 1880, are distinctly in favour of more restricted dimensions in future designs.

Danger to large ships attacked by torpedo-boats concealed in smoke. Captain Colomb, R N.

Smoke will play a most important part in any general engagement at sea. In his paper entitled 'Lessons from Lissa,' Captain Colomb makes the following remarks: 'That which creates all the confusion of a naval battle is the smoke; that part of it which most confuses any particular ship is her own smoke—not her enemy's. If

I, at the distance of a few hundred yards from my enemy, fire my own guns, I cannot for a minute or two see what my enemy is doing: at best, I have but a confused idea of it. If my enemy covers himself with the smoke of his guns, but I abstain from so covering myself, I can quite clearly make out his movements, while I know he must be doubtful about mine. If, therefore, I wish to run him down, I shall hope to see him envelope himself with smoke as soon as possible.'

A vessel having a decided superiority of speed might take advantage of that quality by getting to windward of an enemy, and enveloping him in smoke, which might be generated by artificial means. A torpedo-boat might do this. She might steam to windward of a powerful enemy, blind him with smoke, which would render it impossible to use the guns with effect, and then run him down. When sails were the motive power no rapid movements under cover of the smoke were possible. This consideration alone seems to point to the expediency of restricting the expenditure on individual ships.

Effective ironclads of small dimensions.

It has been argued that a reduction of displacements necessarily involves a corresponding sacrifice of fighting power. Many examples may, however, be quoted where, by ingenuity and contrivance, fighting qualities of a formidable character have been secured in comparatively small ships. Under the directions of Captain Cowper Coles several such vessels were built in the earlier days of armoured construction. The single turret monitors were first constructed in England in 1867 by Messrs. Laird and Napier for the Dutch Government. It may be interesting to note the steps by which Captain Coles' turret system was gradually adopted in vessels of various sizes. The following is a list of the earlier vessels built by Messrs. Laird Bros., viz.:—

Designs by Captain Cowper Coles.

	Draft of water
H.M. ships 'Scorpion' and 'Wivern,' of 1,800 tons and 350 horse-power, each vessel carrying two turrets armed with two 300-pounder guns in each	15 feet to 16 feet
'Huascar,' built for the Peruvian navy, of 1,100 tons and 300 horse-power, with one turret carrying two 300-pounder guns, 4½-in. armour . .	15 feet to 16 feet
'Bahia,' for the Brazilian navy, of 900 tons and 140 horse-power, with one turret carrying two 150-pounder guns, 4½-in. armour . .	8 feet
'Lima Barros,' for the Brazilian navy, of 1,323 tons and 300 horse-power, carrying two turrets with two 150-pounder guns in each, 4½-in. armour .	12 feet
'Prince Hendrik,' for the Dutch navy, of 2,100 tons and 400 horse-power, carrying two turrets with two 300-pounder guns in each, 4½-in. armour .	18 feet

	Draft of water.
'Heiligerlee' and 'Krokodil,' for the Dutch navy, of 1,525 tons and 140 horse-power, each carrying one turret with two 300-pounder guns, 5½-in. armour	9 feet
'De Stier,' for the Dutch navy, of 1,326 tons and 350 horse-power, carrying one turret with two 300-pounder guns, 6-in. armour . .	15 feet

The armour on the turrets of 'Heiligerlee,' 'Krokodil,' and 'De Stier,' is 8 inches thick; the 'Scorpion,' 'Wivern,' and 'Huascar' are protected with 5-in. armour.

The following additional particulars are taken from a paper ('The Turret *v.* the Broadside System') read by Captain Cowper P. Coles before the Royal United Service Institution, May 1, 1867, in which he refers to the performances at sea and in action of several of the ships enumerated by Messrs. Laird.

Among the vessels built from his designs, Captain Cowper Coles described the 'Huascar' as a sea-going vessel of 1,100 tons, 300 horse-power, and a speed of 12½ knots. Her foremast was fitted with tripods; she carried *two* 300-pounders in *one* turret. She made an excellent passage to Rio de Janeiro, and experienced more than one heavy gale on her further voyage to Peru. Her companion, a broadside ironclad of 3,000 tons, and *high* out of the water, made much worse weather of it, arriving at Valparaiso one day after her.

The 'Bahia,' twin screw vessel of 1,000 tons, and 140-horse power, had a speed of 10½ knots, and carried two 150-pounders in one turret. She averaged nearly nine knots on her passage to Rio, and had since been in action on the Paraguayan River, when she was struck by *thirty-nine* 69-pounders. On that occasion the 'Bahia' (turret) and 'Tamandaré' (broadside) went into action together on the Brazilian side, and the Brazilian Admiral made the following official report:—'The ironclads "Bahia" and "Tamandaré" approached the Flat to silence it. The Flat continued to fire on the ironclads, and two balls entering the square box of the "Tamandaré," placed thirty-four men *hors de combat*, ten being killed and twenty-four wounded, the greater number severely. The "Bahia" took position near the fort, and her first shots broke the Paraguayan cannon. The ironclad "Baroso," which likewise went to destroy the Flat, had six men severely wounded, all in her square box. The monitor "Bahia" (late "Minerva," of Liverpool) had no casualties reported, except the wounding of the Commodore while outside the turret. These two vessels were struck respectively by twenty and thirty-nine 68-pounder balls at short range.'

Many other examples of powerful armoured vessels of small dimensions might be quoted.

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The 'King George,' an extremely serviceable ship of the Greek navy, has a displacement of only 1,800 tons. By an ingenious arrangement the guns command an uninterrupted bow and stern fire. The vessel is protected with 7-inch armour, and armed with two 12-ton guns. She is rigged with two masts.

thi nd.'

The 'Fethi Bulend,' of the Turkish navy, with a displacement of under 2,800 tons, is protected over the machinery and boilers by armour equal to that of the 'Hercules.' Outside the vital places the armour at the water-line is six inches, and at the extremities four inches in thickness.

Plata' 'Los les.'

'El Plata' and 'Los Andes' are among the latest productions of this class from the yard of Messrs. Laird. The following is taken from a letter by an officer on board, describing the outward voyage of the 'El Plata' from England to Buenos Ayres in February 1875:—

'Lengthened a little, and given more bunker space, with one 35-ton gun instead of two 12½-ton guns, she would be very valuable on foreign stations; and a small squadron for home service would be proportionately as effective against any enemy as our large turret ships. They are more seaworthy, more easily handled, and far less expensive in fuel, crew, and wear and tear. This ship is 1,800 tons, draws 9 ft. 6 in. aft, and has engines of 750 indicated horse-power. She carries fuel for 2,880 miles under favourable circumstances; is protected with 9-inch armour, and carries two 9-inch, or 12-ton Armstrong guns. The "Devastation" is more than five times the tonnage, and has nearly seven and a half times the horse-power; she has four times the offensive power, and more defensive power also; but the question is, which would be better against an enemy, a "Devastation" with a crew of 350 men, or four "El Platas," each with a crew of eighty-five men?'

mirante hrane' 'Valaiso.'

Among numerous examples of second-class ironclads, the 'Almirante Cochrane' and 'Valparaiso,' designed by Mr. Reed for the Chilian Government, have been specially commended by foreign critics. With a displacement of 3,500 tons, they carry six 9-inch 300-pounder Armstrong guns. They have four guns for bow fire. On the broadside they have three guns, and for stern fire two guns; they are protected with 9-inch armour.

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The 'Vasco de Gama' is another example of the smallest type of ironclads, having a displacement of 2,497 tons. She is armoured on the belt and battery plan, at the water-line with 10-inch plates, and on the transverse bulkheads with 6-inch plates. The armament con-

sists of two 18-ton guns, one $6\frac{1}{2}$-ton gun, and two 40-pounders. The speed is $12\frac{1}{2}$ knots.

In the opinion of many naval officers the most satisfactory ships purchased with the vote of credit are the 'Orion' and 'Belleisle.' They have a displacement of 4,720 tons; they are protected with 10-inch armour on the battery and the water-line. They carry four 25-ton guns, and draw only 16 feet. They steam 14 knots, and possess manœuvring qualities of a very high order. The objectionable features of the battery could have been remedied by subdivision, and by an alteration of the ports. 'Orion' and 'Belle isle.'

The 'Rupert' may be quoted as an example of a serviceable type among the ironclads not of the most recent date. Her superior evolutionary qualities and heavy guns carried in a single turret render her a formidable antagonist to a much larger vessel. More speed might be given to an improved 'Rupert,' by adding to the length and taking from the breadth. Such a change of proportions would involve some loss of handiness; but if we accept ten inches of armour, we must have speed as a compensation. It would be fatal to allow the 'Italia,' with her 100-ton guns, to steam up within pistol-shot and deliver a deliberate fire into the vitals of the ship: but three 'Ruperts' should be more than a match for one 'Italia.' H.M.S. 'Rupert.'

To take another illustration, let us compare the fighting power of an armament as mounted in the 'Téméraire,' and in two ships with a speed of 16 knots, and protected with 10-inch armour. The displacement of the smaller vessels should not exceed 5,000 to 6,000 tons. Their speed should be half a knot faster than that of the 'Duilio,' and their armament should be composed of one 43-ton, two 25-ton, two 18-ton guns, and a sufficient proportion of light guns. According to the plan proposed an equal number of guns would be carried to sea; but we should have two rams for one, and they would be used with more effect by the less ponderous and more agile vessels. The advantage in point of numbers will be equally important for the effective use of the Whitehead torpedo. The expense of building two ships for one will be greater, but the fighting power of the fleet will be proportionately enhanced, and the risks of casualty and destruction will be divided. Design for an improved 'Téméraire.'

The suggestion here put forward is founded on the observations with which Mr. King, of the United States Navy, concludes his account of the 'Inflexible':—

'Every conceivable precaution has been taken to make the "Inflexible" secure against the ram and the torpedo. If, however, she should be fairly struck by several powerful fish torpedoes, Criticisms of Mr. King, U.S.N., on 'Inflexible.'

it is quite probable she would be crippled, water-logged, or possibly sunk. The question therefore presented is whether two vessels of smaller dimensions, each carrying two 81-ton guns, instead of four, would not have been a safer, and, in some respects, a better, investment.

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Having referred to these opinions of eminent authorities on this subject, the arguments for and against heavy ironclads may be summed up as follows. The heavy ships have the advantage in coal endurance, in armament, in capacity to carry large crews, from which detachments may be landed for military operations on shore. The combination of the power both of offence and defence produces a certain moral effect. If sufficiently subdivided, a local injury will produce less effect on a large ship than on a ship of less displacement. On the other hand, their immense costliness and unhandiness constitute serious objections to the first-class ironclads of the most recent construction. In proportion to their tonnage the armament seems insufficient in the number of guns, although it may be admitted that more guns might be mounted if it were thought necessary. There are, however, other objections which cannot by any contrivance of naval architecture be surmounted. Where the fleet is composed of ships which, being huge and costly, must necessarily be few in number, the destruction of a single ship becomes a serious disaster. Again, in naval, as in military tactics, it is an essential object to divide the enemy, and to concentrate in superior strength upon the detached portion of the hostile force. When battles were fought in sailing ships, this tactical advantage was gained by breaking the line. With our steam fleets it is proposed to combine ships in groups of three, both for the offensive and defensive use of the ram. Such concentration becomes impracticable where a squadron composed of ships of superior strength individually is engaged with a fleet composed of a greater number of ships of smaller displacement. Again, in the distribution of a squadron it is often desirable to exhibit the flag in many harbours along an extended line of coast. The recent operations of the navy in Eastern waters afford an illustration of the political importance of the power of distributing a naval force. The great draught of the first-class ironclads prevents them from approaching many important sea-ports, notably those of the eastern seaboard of the United States. The difficulties of coast navigation must necessarily be increased in proportion to the draught of water. The 'Alexandra' grounded in the narrows of the Dardanelles at a critical moment, when the British fleet might possibly have been required to engage the Turkish batteries and open the

way by force into the Sea of Marmora. It is further to be observed that when large ironclads are employed for bombardments, it is impossible to secure the most advantageous use of the artillery by the distribution of the guns in many vessels, and the concentration of their fire on the fortress which is attacked.

It would seem, therefore, that on the first view the balance of argument is strongly against the policy of increasing our expenditure on ironclads so large as those lately added to the navy. There is one argument only in their favour. The French and Italians are continuing to build them. Their sea officers and naval architects may condemn in speech and in pamphlet ships of large and unwieldy dimensions; but the resources of the dockyards are nevertheless appropriated only in a very limited degree to those small and handy ships which are so strongly recommended to us on abstract grounds. We have no choice in the matter—we must meet other Powers on equal terms. Our naval policy cannot be framed independently or on *à priori* reasoning. For armour it may be possible to substitute a more minute internal subdivision as the best means of securing buoyancy, but not a reduction in the power of our guns, as long as other Powers are determined to arm their ships with 100-ton guns.

Our building programme must depend on the policy of foreign Powers. Necessity for a proportion of large ships.

The considerations which must govern the action of the Admiralty in such a case were described by Mr. Barnaby in his pamphlet on Her Majesty's ship 'Inflexible.' He defends the dimensions of the 'Inflexible' entirely on the ground that it was necessary to keep ahead of the Italian constructors in the developments they were resolved upon both in tonnage and armament. In 1873 guns of 70 tons were talked of for foreign ships, but in 1874 guns of 100 tons were already in process of construction, and they were to have 22 inches of armour on their citadels. We had designed the armour to meet the gun of 70 tons; how could we reduce it to meet those of 100 tons? We saw guns of 100 tons preparing to be placed in the hands of Italian gunners; how could we refuse to accept guns of 80 tons for English gunners, if there was any way in which it could be done without sacrificing more important advantages?

Mr. Barnaby on the 'Inflexible.'

Having weighed the conflicting arguments and opinions on the subject of dimensions, let us turn to the main features, which must be combined in a design for a battle ship. A fighting ship must be protected with armour of as great resisting power as possible. The argument in favour of armour protection was clearly stated by Captain Colomb. 'By carrying armour you compel your enemy to

Value of armour.

take a few shots at you in any given time; while, if you carry a greater number of effective guns than he does, you compel him either to increase his armour so as to reduce the number of your guns, or else compel him to abandon armour altogether.' The practical experiences of naval war since the introduction of armour, certainly tend to prove the value of armour protection. It is unnecessary to examine in detail the incidents of the numerous engagements which took place in the Civil War in America. It is well known that the 'Monitors' withstood the fire of the heaviest batteries of the Confederate fortresses with little injury either to the ships or to the crews. M. Marchal refers to the battle of Lissa, as an argument in favour of the retention of armour protection. 'It has been predicted that sooner or later armour must be beaten, and that then the destruction will greatly exceed that which would take place in an unarmoured ship. Here, in fact, lies the whole question —Is the final result more disastrous for the armoured than the unarmoured ship? This is what experience alone can determine. At Lissa the Austrian loss was 136 men, 105 of whom belonged to the 'Kaiser,' an unarmoured ship. This disproportion was not due to the fact that the Italian guns were impotent against the Austrian ironclads. Four of their ships carried each of them two 300-pounder Armstrongs, and the Austrian ironclads were protected with armour of only 12 centimetres, or five inches, in thickness.'

Another very eminent French constructor, M. Dislère, the author of *La Marine Cuirassée*, while arguing for the abandonment of armour in sea-going ironclads intended to cruise on the ocean, urges with equal confidence that armour is indispensable for ships designed for coast service:—

'La puissance défensive, la protection des murailles et des ponts, doit être assurée par le maximum du cuirassement, et si, pour le navire d'escadre, nous prévoyons la nécessité d'enlever successivement les diverses pièces de la cuirasse, si nous pensons que, dès maintenant, il faut renoncer à protéger l'artillerie, et que, dans un avenir assez prochain peut-être, on sera amené à retirer des flancs de la flottaison les dernières plaques de cette armure nuisible par cela même qu'elle sera devenue impuissante et inutile, nous croyons qu'il n'en est pas de même du navire garde-côtes. On peut, pour lui, se contenter d'une vitesse modérée, d'un approvisionnement de charbon très-réduit, et porter sur la puissance défensive toute l'économie que l'on réalisera sur les autres parties du déplacement; on aura évidemment pour ce but des navires presque aussi grands que les cuirassés d'escadre, des navires coûtant de 8 à 9 millions, pouvant couler,

il est vrai, sur place par le fait seul d'une torpille heureusement placée, mais ils seront à l'abri de l'artillerie ennemie, et quand on aura sacrifié pour forcer une passe, comme l'amiral Farragut le fit à Mobile, un ou deux navires d'importance relative moins grande, les garde-côtes offensifs pourront défiler impunément sous le feu des forts, et garderont sur eux, cela est probable du moins, l'avantage que pendant la guerre d'Amérique les flottes cuisassées ont eu sur les défenses de terre. Quant aux garde-côtes défensifs, leur rôle sera tout différent: ils pourront également conserver une cuirasse les mettant à l'abri de l'artillerie; mais, ayant besoin d'une vitesse plus grande, de qualités évolutives plus complètes, ils ne pourront les réaliser qu'en se débarrassant entièrement de leur artillerie et en se renfermant dans leur véritable rôle, celui de bélier cuirassé.'

'Shah' and 'Huascar.'

The advantages of armour were signally illustrated in the engagement between the 'Shah' and the 'Huascar.' The 'Huascar' was armoured with only 5-inch plates, and though struck eighty times with shot from two 12-ton, sixteen 4½-ton guns, and twenty-two 64-pounders, she remained uninjured.

Captain Chatfield, R.N.

The following is from notes of a conversation with Captain Chatfield, who commanded the 'Amethyst' on the occasion of the action between that vessel, the 'Shah,' and the 'Huascar.' Captain Chatfield's experiences in the action with the 'Huascar' impressed him strongly with the advantage of armour. The 'Huascar' was struck a hundred times by the 'Amethyst,' but was never injured. Shells, the most dangerous form of projectile, can be kept out by armour of quite moderate thickness. Solid shot are less destructive, and may be suffered to penetrate and pass through. The introduction of the chambered system gives greatly increased power to the gun, and will probably lead to a reduction in the weight of the armament; while thinner armour, capable of keeping out shells, will probably be retained for every fighting vessel. Armament and armour of the character indicated can be combined in vessels of reasonable dimensions and cost.

Armour may be of moderate thickness.

While protection will be admitted to be indispensable for all battle ships, whether by means of side armour, or by a convex armoured deck as now proposed by our constructors, it does not follow that the plates must be impenetrable, when struck normally by the ponderous projectiles of the 80-ton or the 100-ton guns. One hundred and sixty ton guns have indeed been proposed; and the authors of *Die Marine* have pointed out that armour one metre in thickness would be needed to keep out shot from such formidable ordnance. They estimate the displacement of a vessel capable of

supporting such a burthen of defensive armour at 20,603 tons. The cost of ironclads has been advancing with giant strides, from sums of 350,000*l.* or 400,000*l.* in 1869, to amounts varying from 600,000*l.* to 800,000*l.* at the present day. It is evident that we must stop short of absolute impenetrability. It will be sufficient if we can keep out the shell of the lighter artillery, which might inflict havoc and destruction upon an unarmoured ship, but can be resisted by plates of less than half the thickness of the armour which loads the 'Italia' and 'Inflexible' with an oppressive and almost insupportable burden. Captain Colomb asks for ten-inch armour, the Controller demands twenty inches of armour.

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The protection of the deck must be considered in connection with the general subject of defence by means of armour. The necessity for such protection has been shown in frequent instances. The smallest shell falling on the deck may penetrate it and destroy the machinery, or blow up the magazines.

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The results of experimental firing seem to show that an air space between two thicknesses of armour affords a means of protection, the efficacy of which might be tested by further experiments. The following observations on this point are taken from M. Dislère's work *La Guerre d'Escadre*:—

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'Quels que soient d'ailleurs les avantages et les inconvénients des deux systèmes, il est incontestable que, dans la situation actuelle de l'artillerie, les cuirasses dédoublées peuvent rendre de très-réels services. Dans les combats de l'avenir, il ne faut plus guère compter sur les projectiles massifs en fer, en fonte dure ou en acier; ce seront les obus en acier qui tôt ou tard remplaceront sans nul doute tous les autres projectiles. Or, il paraît bien difficile de trouver un procédé de mise en feu qui permette à l'obus de traverser une muraille cuirassée d'une certaine épaisseur sans prendre feu. Avec les mécanismes percutants, la mise en feu est presque instantanée; avec les dispositifs ayant pour but de produire l'explosion par la chaleur développée pendant le travail de percement, il est bien probable qu'on cherchera toujours à régler les épaisseurs, à composer les charges d'éclatement de manière à produire l'inflammation même dans des murailles d'épaisseur moyenne; on préférera produire l'explosion au milieu de la cuirasse plutôt que de ne pas la produire. Si donc on cherche l'épaisseur de cuirasse strictement suffisante pour donner naissance à l'explosion, il conviendrait alors de composer la muraille de deux épaisseurs, l'une extérieure, faisant éclater le projectile, l'autre intérieure et arrêtant les éclats. Mais ce ne sont là jusqu'à présent que des déductions très-hypothétiques et dont on

ne pourra déterminer l'importance qu'après de longues et coûteuses expériences.' These remarks deserve consideration in connection with the programme of shipbuilding.

The weight of armour has been materially reduced by the introduction of steel-faced plates. The turrets of the 'Inflexible' will be protected with a double belt of compound armour, respectively nine inches and seven inches in thickness, in substitution for two layers of twelve-inch plating. It is possible that the protection of the earlier ironclads might be increased with a comparatively small addition to the weight of armour by means of a facing plate of steel, which might be fixed outside the iron armour of the larger ironclads, such as the 'Achilles' and 'Northumberland.' **Steel-faced armour.**

History repeats itself in naval architecture, as in other things. The 'New Ironsides,' one of the heaviest ironclads built in the American Civil War, was protected with inverted armour, the upper deck being roofed over with plates, presenting an oblique angle to the impact of shot. The convex deck, proposed by our constructors as the best means of giving protection, without resorting to extreme dimensions, seems a revival or rather adaptation of an old idea. **Inverted armour.**

Whatever be the improvements effected in the methods of protecting ships of war by means of armour, it is obvious that the torpedo and the gun must be resisted not so much by external armour as by internal subdivisions. It is only by localising injuries that the construction of the large and costly ships of the first-class can be defended. In his paper on the 'Inflexible,' Mr. Barnaby recommended that buoyancy and stability should be secured by an unarmoured cellular structure, while the guns were mounted in separate armoured citadels. With these opinions of Mr. Barnaby, M. Dislère entirely concurs in his remarks on this subject in *La Marine Cuirassée*. **Importance of cellular subdivision.**

In his paper on the 'Maritime Defence of England,' Admiral Scott expresses his conviction that the officers of the Navy generally will concur with him in thinking that one half or more of the thickness of armour on the top sides of our ships should be given up, and that a corresponding weight of iron should be employed to strengthen the bottom of the ship, and to render her cellular subdivision more complete. **Admiral Scott.**

Infinite subdivisions into watertight compartments are the only means by which the dangers of torpedo attack can be avoided. The bulkheads should be multiplied in all directions, longitudinally as well as transversely. With longitudinal bulkheads forming an inner **Longitudinal bulkheads.**

wing passage, as fitted in the 'Friedrich Karl,' neither the 'Vanguard' nor the 'Grosser Kurfürst' would have been destroyed by a single blow of the ram.

The admirable plan devised by Mr. Barnaby of a middle line bulkhead, dividing the engine and boiler rooms of our ships of war, is one of the most valuable improvements of recent times. As Captain Colomb remarks in his Prize Essay of 1878: 'In every class of war ship a great principle should, as far as possible, govern construction. This is the principle of duality. Thus for a fleet ship she should be double, below water, her engines should be double, with a double set of boilers each in a separate compartment.'

Having determined that our battle ships are to be armoured at the water-line, and in vital places, with plating of no less than ten inches in thickness, we proceed to consider the question of armament. It is not necessary to arm our ships exclusively or mainly with guns of 100 tons in order to penetrate the armour of the ships with which they may most probably be engaged.

Many arguments may be urged for and against an armament of very heavy calibres. Commander Noel says, in his essay, 'The Gun, the Ram, and the Torpedo': 'The effect of the heaviest ordnance is no doubt extremely destructive, if the object be hit; but enormous ships are required to carry such monsters, and even then only a very few can be mounted. A small percentage of projectiles can possibly take effect when the combatants are moving at the high speed now to be attained. The next general action will show that a larger number of guns of a lesser calibre will be of greater service.'

The following extract from Captain Colomb's paper, 'Lessons from Lissa,' gives expression to the same opinion, founded on recent and practical experiences:—

'In 1862, the effect of this connection of rapid motion with gun practice was commented on in a very able and practical little pamphlet, by Lieutenant Duncan Stewart. He says, speaking of some experiments of Admiral Martin in 1861: "I must confess I was greatly astonished to find how few shots could be got at a ship whilst passing the one I was in. It must be taken into consideration that there was no smoke to intercept a clear view of the other ships—that there was no firing upon the ship I was in, and consequently no confusion—that, in short, everything was in our favour; yet so difficult did I find it for captains of guns to get a shot in close action, that I am forced to doubt whether it would not be advantageous todiscontinue the practice of extreme training, except at very long distances, and

leave it to the helm to keep the object within easy training of the guns pointed abeam." '

In the discussion at the United Service Institution on Captain Colomb's paper, 'Lessons from Lissa,' Sir Henry Codrington said:— Sir Henry Codrington.

'I do not know anything that is more liable to be overturned than any theory we can form of battles on general principles. One thing will last for ever; that close action, be it with our rams or whatever it may be, is a system we must make up our minds to, as a thing more consistent with our English character and more suited to it than fighting at long range.'

This opinion is confirmed by Mr. Holley in section 242 of his treatise on 'Ordnance and Armour.' He says: 'In the field it is admitted that the difficulty of judging distances and other disturbing circumstances are such as to confine the ranges of projectiles for military purposes to 2,000 yards. Afloat the disturbing causes, *which are constant*, are greater, from which the various movements in rifle-sights become causes of error. Effective ironclad fighting will undoubtedly be done at short range.' Mr. Holley.

The subject of armament was thoroughly considered in the discussion at the United Service Institution on the Naval Prize Essays of 1878.

Commander W. Dawson, R.N., said: 'The great mistake in the armament of our ships is not only that the weight of ordnance carried is too small in proportion to tonnage, but that the individual guns are not sufficiently varied to enable them to fight vessels of dissimilar classes. Commander Dawson, R.N.

'I have always advocated mixed armaments. Each ship of war should not only carry a few large guns, which will penetrate the thicker-sided vessels, but also a number of smaller and, it may be, less protected guns, for the purpose of penetrating the thinner-sided vessels. If the "Inflexible" be attacked by a number of thin-sided vessels carrying heavy ordnance, she ought to be able to defend herself against those vessels which actually exist, and might readily be multiplied, quite as much as against another "Inflexible," of which very few exist or can be quickly produced.'

Admiral Hamilton, C.B., said: 'My idea is with Admiral Porter, that you must have your broadside ships for rapidity of fire to keep down that of the enemy, and at the same time you require heavy monitor and turret ships, where men can fire perfectly under shelter, to implant the heavy blow. Therefore I go in for mixed armaments.' Admiral Hamilton, C.B.

Commander Gerard Noel said: 'As regards gun power I would ask those interested in it to study the first three tables in my essay. Commander Noel, R.N.

They tend to prove—and I think the data are pretty good—that if you have 1,000 tons of armament to carry in a sea-going vessel, the 9-inch gun is the one you can carry with most effect. If you wish to put 1,000 tons of armament into your vessel, you could put thirty 9-inch guns, and that would give a result of throwing five times as much weight as system 1; that is, four 80-ton guns, which would constitute the same weight of armament, and 2½ times as much as system 3, that is, twelve 35-ton guns. I always have been very much opposed in my humble way to a small number of large guns, putting all your eggs into one basket. If your gun is disabled, where are you? If you have a large number of guns, half of them may be disabled, and you have still the other half to fight.'

Captain Cyprian A. G. Bridge, R.N.

Captain Cyprian A. G. Bridge, R.N., said: 'All the essayists are agreed with Captain Colomb where he says it is an error to suppose that guns of 80 tons and upwards are the guns of the future. I do not think any one of them proposes a gun of anything like that weight; 38-tons as an exceptional weapon, and guns of 18 to 20 tons seem to be those which find most favour with them all.'

Rear-Admiral Sir Edmund Commerell, K.C.B.

Speaking at the United Service Institution on June 8, 1877, Sir Edmund Commerell said: 'We have ships of 9,000 tons displacement carrying only 140 tons of ordnance. We have ships of 11,000 tons carrying only 320 tons of ordnance. Such ships would be far more powerful if they could substitute 200 or 300 tons of ordnance for an equal weight of defensive armour. British corvettes, sloops, and frigates should not be without armour-piercing guns. The "Shah," and the "Amethyst" were almost inoffensive when called upon to attack the "Huascar."'

Report of the Secretary of the U.S.N., 1878.

The Secretary of the United States Navy, in his report for 1878, gives expression to an opinion which may be quoted in confirmation of these views: 'In the European experiments both guns and targets have been stationary. The process of firing by one ship at another ship is a different thing. It is yet doubtful whether these large expenditures are justifiable, when it is considered that, where one projectile will strike the narrow surface exposed upon a monitor, a large number will fail to do so.'

M. Marchal.

The necessity for introducing lighter guns is enforced by M. Marchal in the following passage: 'Ironclads have been proposed to carry a mixed armament of many small guns, which were to be provided with armour solely for the purpose of protecting the hull. The guns in this case would not be intended to sink the hostile ship, but with the aid of the continuous fire of small arms they would silence the heavy guns of the enemy, or at least render it impossible to work

them by shooting down the gun's crews. Tactics of this nature might be attended with success.'

Committee on designs.

These opinions are supported by the high authority of the Committee on Designs—'As it is very improbable that the fleet of any nation will ever consist of armoured coast defence ships alone, we think that a composite armament of protected and unprotected guns will in some cases be highly advantageous. Occasions may arise on which a rapid and well-sustained fire would be of more importance than the penetrative power.'

Penetrative power of naval guns.

The practice with naval guns in action at distances exceeding 1,000 yards will be so uncertain that it is not necessary to consider the penetrative power of guns beyond that limit. It is indeed more than probable that the effective fire of guns will be delivered within rather than beyond a range of 500 yards. The 25-ton gun penetrates the water-line of the 'Peter the Great' at 500 yards, and will penetrate the armour of the greater majority of foreign ironclads at more than double that distance. A gun of one-half the weight is effective at 600 yards against armour of a thickness that is to be found in comparatively few ironclads in the navies of foreign Powers. The Armstrong 6-inch gun penetrates eleven inches into a 13-inch plate at 100 yards. A Krupp 18-ton gun with a steel projectile went right through a 12-inch plate and an 8-inch plate at a distance of 164 yards. At a range of 1,000 yards the 12-ton guns penetrate 9½-inch armour; the 18-ton gun 11½-inch; the 25-ton 12½-inch; and the 38-ton gun 15½-inch armour.

Of vessels protected with armour exceeding 9½ inches, Austria, Brazil, Denmark, and Holland possess each one ship. France has nineteen, Germany nine, Italy four, Russia seventeen, and Turkey two such ships; and against these the 18-ton gun will be an effective weapon. Of ships protected by armour exceeding 12½ inches, and capable of resisting the 25-ton gun at 1,000 yards, Austria possesses one, France eight, Italy two, and Russia one. Of ships protected by armour exceeding 15½ inches, and impenetrable by the 38-ton gun at 1,000 yards, France has two and Italy two.

General conclusions as to armament.

It is important to observe that in all cases in proportion to the increased thickness, so the area protected is reduced. The unprotected surface of the most heavily armoured ships is so large that when riddled through and through even by the lightest projectiles, they would probably be *hors de combat*. The admission of water into a few compartments would alter the trim, and leave the large and unhandy ships an easy prey to the rams and torpedo boats. The inference would therefore be that for the practical purposes of war

the first-class ships need not be armed with a heavier weapon than the improved 43-ton gun.

Every battle-ship should carry one or two guns which will penetrate the thickest armour, but their armament should include in larger proportion than heretofore guns of a lighter calibre, capable of keeping up an incessant and destructive fire against the thinly-plated ships and the large area of unprotected side of the most heavily armoured vessels.

The fire of a single monster gun is more effective than a concentrated broadside. It is more easy to protect by armour one gun, or few guns, than many guns. But there may be great advantages in smaller guns, that can be more quickly loaded. When the first shot misses its aim, all must depend on the rapidity with which the second shot can be delivered.

If foreign Powers determine on arming their ships with monster guns, we must answer them; but we may meet the efforts of our maritime rivals by dividing our heaviest guns among a greater number of ships, and combining with one or two guns of the heaviest calibre an armament of guns of the lighter natures.

pari- of the dside turret

Passing from the guns to the system of mounting, we have to decide between the relative advantages afforded by the turret and the broadside. When it is desired to carry heavy guns in a ship of small tonnage, the armament must be placed on a revolving platform amidships. On the other hand, in the case of masted vessels it becomes impossible to carry all the armament in turrets, without sacrificing the principal advantage of the system,—the large range of horizontal command.

A mixed armament can only be carried in a ship in which the broadside and the turret are combined. By those who believe that the manœuvres of ships in a general engagement will be carried on chiefly with the view to the use of the ram, it has been contended that the armament should be concentrated in the bow. The greater effectiveness of broadside fire, when a fair opportunity arises for the use of the guns, was clearly shown by Sir Cooper Key, in a speech at the United Service Institution. His views are given in the following extract:—

Cooper B.

'I am decidedly an advocate for the use of broadside armament. In the first place the more guns you can bring to bear, the better; but also the great disadvantage of end-on fire is this—you must be in rapid motion. You are changing your distances constantly, and so is your antagonist. You have no certainty of what your accurate

distance is; and I am therefore satisfied that when you are approaching an enemy end-on, your fire will be thrown away; whereas, when you can bring your broadside to bear, your own distance is not altering, and you can judge your distance with far more certainty than you can whilst approaching end-on, besides being able to bring the greater power of your ship to bear on the enemy. But although I strongly advocate bringing your broadside to bear whenever it is practicable, yet I should not recommend a ship being armed only on the broadside. It may happen that your steering power or your motive power becomes disabled, and then you must resort to bow or stern fire. There are also occasions in narrow waters in rivers—or the vicinity of shoals, and with your ship placed in various positions when bow and stern fire is of great importance: therefore, I should never think of advocating the arming of ships so that they could not fire in every direction round the horizon; that is, having one or two guns bearing on every point of the compass.'

The difficulty of bringing the bow guns into action to support the attack with the ram was strongly insisted on by Admiral Jurien de la Gravière: 'As an enemy advances, an armoured vessel cannot do better than impose silence on her artillery. The advantage to be gained by a discharge rendered uncertain by the rapidity with which the distance varies, cannot compensate for the disadvantage of the cloud of smoke which would envelope the ship at the all-important moment when her safety depends on the precision with which she is handled.' **Admiral Jurien de la Gravière.**

In the 'Alexandra' the broadside has been brought to a hitherto unknown perfection. The facilities, which the broadside affords for multiplying guns of the more moderate calibres, seem to point to a combination of the turret with the broadside, as presenting the best solution of the shipbuilding problem at the present time. In ships of moderate dimensions we must be satisfied with a central battery surmounted by a barbette tower carrying one heavy gun; or the tower may be placed, as in the 'Sachsen,' on the upper deck, level with, but forward of, the battery. The French have never adopted the enclosed and armoured turret, and have preferred to mount their guns in fixed towers *en barbette*. For the heavier guns, the turret system is indispensable. Its advantages were well described by Admiral Touchard in his pamphlet, *La Question du Décuirassement*. The weight of the projectile is of no value, if it fails to hit the mark. In a 120-gun ship, if one shot missed it was nothing. In the case of the armoured ship to lose one out of eight or ten shots is a serious question. Every great gun should have an extended range **Armament of H.M.S. 'Alexandra.'** **Admiral Touchard.**

of fire which can be swept freely and rapidly. The captain of the gun must be able to keep his eye constantly on the object, in order to make use of a favourable moment for firing. Is it possible to accomplish this with guns mounted on the broadside, and when the object can only be seen through a narrow port-hole, obscured with smoke and almost blocked up by the muzzle of the gun?'

Admiral Touchard prefers, as the best type for an ocean-going fighting ship, an armoured vessel, with the heavy guns mounted *en barbette*, on central pivots, in a single line along the centre of the ship. The advantages of this armament are, that the gun can be directed to any point of the horizon, and that in the decisive moment, when vessels are charging past one another, all the guns can be directed upon the enemy, while in the central battery ship only half the guns can be brought into action. The armament of the combined barbette and battery ships now building in France is disposed in conformity with the recommendations of Admiral Touchard.

N. ers.

The officers of the United States Navy are unanimous in favour of the Monitor type for the heavy guns required in a bombardment; they are not prepared, however, to depend solely on turret ships, but rather to regard them as coadjutors in the fight, to put in the occasional heavy blows in combination with the more rapid fire of the lighter guns of the broadside vessels.

The necessity for a high freeboard constitutes another argument for the broadside. A turret ship may be safe, but is neither pleasant nor wholesome to live in at sea. The 'Thunderer' has the reputation of being wonderfully handy and buoyant, but when battened down the crew suffer serious discomfort from the darkness and the heat.

mples e combi-tion of et and dside aments.

Examples of the combination of the turret with the battery are very numerous among the later constructions of foreign navies. The list of armoured ships of this type includes the Danish ship 'Helgoland,' 5,347 tons, armed with one 30-c/m and four 26-c/m Krupp guns, and the German corvettes of the 'Sachsen' type, five in number, of 7,400 tons displacement, and armed with six 26-c/m Krupp guns.[1] The French navy is particularly strong in the class in question. The list comprises the three sister-ships, 'Océan,' 'Marengo,' and 'Suffren,' of 7,749 tons displacement, armed with four 27-c/m guns in the casemated battery, four 24-c/m guns in

[1] Krupp 30 c/m = 12 inch 36½ tons.	French 27 c/m = 10·3 inch 20·6 tons.
„ 26 c/m = 10·5 „ 22 „	„ 24 c/m = 9·4 „ 14·2 „
French 34 c/m = 13½ „ 47½ „	„ 14 c/m = 5·4 „ 52 cwts.

towers at the angles of the battery, and six 12-c/m guns on the upper deck. The 'Richelieu,' 'Colbert,' 'Friedland,' and 'Trident,' are of 8,791 tons displacement. They are armed with four 27-c/m guns in the casemate battery, four 24-c/m guns in four barbette towers over the angles of the battery, one 24-c/m gun under the forecastle, and ten 12-c/m guns on the upper deck. The 'Friedland,' with a displacement of 8,916 tons, carries an armament of six 27-c/m guns in the casemate, and two guns of the same calibre in elliptic half-towers, and eight 14-c/m guns on the upper deck. The 'Redoubtable,' of 8,854 tons displacement, carries an armament of four 27-c/m guns in a casemate, two guns of the same calibre in barbette turrets, another under the forecastle, and a fourth under the poop, and six 14-c/m guns on the upper deck. The 'Dévastation' and 'Foudroyant,' of 9,639 tons, carry an armament of four 34-c/m guns in a casemate, two 27-c/m guns in half-turrets, and six 14-c/m guns on the upper deck. The 'Duperré,' of 10,486 tons, carries an armament of four 34-c/m guns in turrets, and fourteen 14-c/m guns in an unarmoured battery. The 'Amiral Baudin' and 'Formidable,' of 11,441 tons, carry three 100-ton guns in turrets, and twelve 14-c/m guns in the unarmoured battery. In the numerous second-class ironclads of the 'Alma' class we find the turret and broadside systems similarly combined. It is the same with the large second-class ships of the 'Victorieuse' type. The latest type of second-class ironclads in the French navy consists of the 'Duguesclin,' 'Vauban,' 'Bayard,' and 'Turenne,' of 5,869 tons. They carry an armament of four 24-c/m guns in barbette towers, one 19-c/m gun in the forecastle, and six 14-c/m guns in the battery.

In the Russian navy the 'Minin,' of 5,855 tons, carries four 8-inch guns in half-turrets, and twelve 6-inch guns on the broadside. The mixed broadside and turret type is represented in the Turkish fleet by the 'Assar-I-Tefvik,' of 5,687 tons, carrying two 12½-ton Armstrongs in barbette towers on the upper deck, and six guns of the same calibre on the broadside in the main-deck casemated battery.

General conclusion as to systems of mounting.

The opinions and the facts which have here been brought together seem to point distinctly to the conclusion, that as the armament of a battle-ship should be of a mixed character, so in the methods of mounting the guns a certain compromise should be effected by combining the turret for the heavy guns with the broadside system for the moderate calibres. The turret should be placed either forward of or above the central battery, so as to secure for the heaviest guns the utmost range of fire both vertically and horizontally.

Masting of ironclads.

We proceed in the next place to consider the arguments for and against masting in armoured ships. The combination of the turret with the broadside is a type which admits of masting, but it is impossible that an ironclad, having the large displacement of the more recent vessel, can be sufficiently masted to cruise under canvas, without suffering in some material points in efficiency for war service.

Sir Edward Reed. Extracts from *Our Ironclad Ships.*

The results of the effort to combine sail power with steam in the earlier ironclads of more moderate dimensions were not unsuccessful. Sir Edward Reed, in his volume on *Our Ironclad Ships*, gives a general summary of the reports received at the Admiralty from the officers in command :—

Sir Sydney Dacres, quoted by Sir Edward Reed.

'In the Report of Rear-Admiral Sir Sydney Dacres, for 1864, we find the following statements. During the passage from Lisbon to Portland, the sailing of the 'Warrior' and 'Black Prince' was good, enabling them to keep company with the 'Edgar' (screw line-of-battle ship) under sail only. Captain (now Admiral) Hornby, of the latter vessel, observes that, though under sail, the 'Edgar' "has generally an advantage ; in a head sea, as well as in steaming, the finer bows and long floors of the iron ships give them a great superiority." In his remarks on the qualities of the ironclads (see page 8 of the Parliamentary Return), Admiral Dacres says of the "Warrior" and "Black Prince" that, "even as at present rigged, their sailing qualities on a wind on long stretches make them equal to keeping pace with vessels of the old class," and then adds, "the great drawback to the many excellencies of this class is, that their extreme length interferes with their handiness in many most important points." Among other points in which this unhandiness was felt, he mentions wearing and staying under sail, and the rounding-to of the ships when scudding. These drawbacks were, of course, incidental to the great length, and not to the armour-plating of the ships. In the course of his further observations he states that the "Defence" (a short ship) "is as handy in wearing and stays as anyone could desire ;" and that the "Prince Consort" and "Royal Oak" (two of the short converted ships of the "Caledonia" class) "are handy, though slow under sail." Admiral Yelverton (in his Report for 1866) says, with respect to the sailing powers of the ironclads: "On both these occasions I was able to judge of the performance of the squadron, blowing hard and with a heavy sea, and have no hesitation in saying that, under all the ordinary circumstances of bad weather in the Atlantic, I see no reason to apprehend that the ships of this squadron would make worse weather of it than

any of our line-of-battle ships." He excepts two vessels from this statement, the "Hector," which has always proved an inferior sea-boat, and the turret-ship "Wivern." In his remarks on the individual merits and deficiencies of the ships, the Admiral states that the "Achilles" is "a safe and good sea-boat," although, "from her great length, most difficult to handle;" that the "Bellerophon" "is weatherly both in light and strong winds," although, as he supposes, the very large area of the balanced rudder tends "to stop the ship's way too suddenly under sail," and often causes her to miss stays; that the "Lord Clyde," "Ocean," and "Caledonia," though not equal to the old line-of-battle ships as regards their sailing capabilities, are most efficient ships of war; that the "Pallas," a comparatively small ship, "on all occasions of sailing, whether on a wind or going free, proved herself far superior to the rest of the squadron;" adding, "I may safely class her, in point of sailing, with some of our good 36-gun frigates of other days;" and that the "Research" "sails well at all times both when closehauled and going free." In Rear-Admiral Warden's Report to Admiral Yelverton on the behaviour of the ships during the same cruise, we find them placed in the following order of precedence as regards performance under sail:—"Pallas," "Research," "Bellerophon," "Ocean," "Hector," "Achilles," "Lord Clyde," and "Caledonia." Admiral Warden adds—"With regard to the quantity of sail-power carried by the several ships, I should say that generally it is quite sufficient; I do not think it ought to be less, considering the various duties they may be called upon to perform; nor do I consider that it could be increased with advantage, or without incurring the risk of impairing their efficiency under steam. It is quite sufficient for all general purposes, for assisting them to make long passages to distant stations, for the purpose of economising fuel on general service, as has been exemplified during the last month." Admiral Yelverton's report confirms the accuracy of these remarks; but both officers agree in the opinion that, if the fleet were required to perform evolutions under sail, all the ships would need steam-power to ensure a certain and prompt performance of them. Admiral Yelverton further states, however, that, "as they are now rigged, they are able to keep their positions in any assigned latitude and longitude, tacking, and even wearing, with little doubt, provided there be plenty of sea-room, and that they are not in line, nor called on to perform any manœuvres or evolutions of a fleet."

Rear-Admiral Warden.

Admiral Yelverton.

'I cannot recommend that larger masts and yards be placed in the "Caledonia" and "Ocean" class, or indeed in any of the ships

of this squadron, for most assuredly their steaming qualities would diminish in proportion, and steam, which is their principal power, would be sacrificed to a doubtful issue as regards sailing.

'Whatever our predilections may be in favour of sailing-ships, we must not forget the specific and warlike purpose for which these vessels were built, not for circumnavigation, most assuredly, but for contending, on fairly equal terms, with the similar construction of our neighbours, such as the ironclads of France and Italy, of which I have seen a great deal during the last three years in the Mediterranean.

'It is not fair to expect an ironclad to be as good a cruiser as an ordinary ship, but if she can keep her position under sail off an enemy's port, without having recourse to steam, and make the best of such weather as she will there find; if her powers of offence and defence in action are equal with what she will meet with on the high seas, and she carries a substantial armament, well mounted, and well out of water, all that could reasonably be expected of her as a cruiser is gained, and we must be content with a good steamer and a stout fighting ship, to the exclusion of a fast-sailing one.

'These facts will serve to show the reader that our ironclads, whatever their imperfections as sailing ships, are not deficient in sailing powers as far as they are requisite in sea-going cruisers possessing steam power also. The capability of these ships to undertake the most distant voyages cannot, however, be better illustrated than by a brief reference to the performances of one or two of them, and those not by any means the best sea-boats of the armoured fleet. Lord Henry Lennox, in one of his speeches on the Navy Estimates in 1868, referred to a voyage made by the converted ironclad "Ocean" from the Mediterranean to Batavia. In the course of this voyage the ship encountered very severe weather, especially after passing the meridian of the Cape of Good Hope on the way to St. Paul's Island in mid-ocean. Some idea of the violence of this storm may be obtained from the fact that every boat at the davits was stove. One of the officers, writing on this subject, observed—"No wooden ship could have gone through it better, and a good many worse." He also stated that "under sail alone we have gone 12 knots," and that the runs made per day varied from 195 to 243 knots, the latter giving an average speed of more than 10 knots per hour. If any additional proof were required of the capability of our ironclads to proceed to any part of the world, the voyage of the "Zealous" to Vancouver's Island might be mentioned, as she also encountered heavy weather and behaved admirably.'

The performances of the 'Zealous' were referred to in the discussion on the 'Naval Essays of 1878' at the United Service Institution, where it was stated by Captain Curtis that, during her last commission in the Pacific, she had covered 30,000 miles with 1,600 tons of coal. H.M.S. 'Zealous.'

As another example of the successful combination of sail with steam, I may refer to the 'Monarch,' of which Sir E. Reed spoke in terms of satisfaction in a lecture at the Society of Arts, on the modifications in the naval architecture of the last twenty years, as having performed the voyage to America and back without the slightest difficulty with regard to fuel, using sails as an auxiliary. H.M.S. 'Monarch.'

As the tonnage of the ships has been increased, and the dead weight of armour piled up on the sides of ships has become more ponderous, the sail power has necessarily become less effective. The opinion of the Committee on Designs is recorded in the following passage:—

'It is with much reluctance that a majority of our number have arrived at an opinion adverse to the full rig for ironclad ships. We all view with regret what presents itself to the minds of most of us as the inevitable failure of the attempt to unite in one ship a very high degree of offensive and defensive power with real efficiency under sail. We find ourselves compelled to regard the attainment of this very desirable object as an insoluble problem. Our transmarine possessions will be more efficiently protected by the establishment, where requisite, of centres of naval power, from which vessels of the "Devastation" class may operate, than by relying upon cruising ships of such limited fighting power as the "Monarch."' Committee on Designs.

This opinion, expressed by the Committee on Designs, is strongly confirmed by Admiral Touchard, in his pamphlet entitled *Encore la Question du Décuirassement*: 'Before coming to any decision in reference to a ship-building policy, it is necessary to define the aims and objects which we should seek to attain in the warlike operations to be undertaken. Supremacy at sea must depend on the result of engagements fought chiefly in European seas. So much is certain. In a theatre of action thus confined, and with a view to a definite operation of war—an operation limited in range, both of space and of time, and carried on within reach of anchorages and supplies, the English "Inflexible" or any other ship of that type and that strength will be destined to play a preponderating part. For operations of the character indicated, a ship of the "Dévastation" type is the most powerful battle-ship, the only one which combines the maximum of Admiral Touchard.

offensive and defensive power; and this type must be included in the programme of construction of our navy.'

Commander Hayes, R.N.

In order to show how generally the opinions already quoted are entertained, the following passage is taken from the Naval Prize Essay, by Commander Hayes, R.N.:—

'In the opinion of many naval officers, full-rigged ships—however valuable in peace-time for the purpose of keeping up the nerve and activity of the seamen—will, in time of war, find their sail-power a fertile cause of disaster.'

Sir Thomas Symonds, K.C.B.

Sir Thomas Symonds, K.C.B., in a letter to the First Lord of the Admiralty, dated Torquay, June 1, 1874, and afterwards published in the newspapers, writes, with reference to the 'Vanguard,' '. . . to carry large masts, the greatest enemy of all on board.'

'Nothing can well cripple a ship more than a foul screw.

'Falling spars, blocks, &c., would cause many casualties, and would also impede the working of the upper-deck guns. Large masts and sails retard an ironclad when steaming head to wind, more than they would help her sailing with a fair one.

'If the heavy masts were removed, ballast would be unnecessary, the draught of water would be lightened, and the sail and store rooms might be utilised for stowing coal or torpedoes.

'It may be safely asserted that no other nation holds such admirable positions throughout the world for coaling depôts as Great Britain; this will give her an overwhelming advantage in maritime warfare, provided only she takes care to make them secure and keeps them well supplied.

'As long, therefore, as we hold these depôts, sail power may be dispensed with to a very great extent, except on some stations where the coaling stations are few and far between, as in the Pacific and South Atlantic. The advantage of hydraulic propulsion for those cruisers obliged to carry sail is obvious.

'Cruisers with sail power should be thoroughly efficient under sail alone. Sailing trials would be necessary to prove them so; they should have a light spar deck to protect their guns from falling gear; they would require a smart ship's company to make the most of the sails, and to prepare the ship quickly for action, with spare hands for prize crews.

'North of the trade winds in the Atlantic neither ironclads nor cruisers should be masted for sailing.

'The Singapore division of the China station, for instance, would not require sail power, neither would the vessels permanently attached to the depôts, as their radius of operation is limited.'

Belief in the merely partial value of sails, as an auxiliary to the steam power in large ironclads, is amply confirmed by the separate reports of the officers commanding the ships composing the squadron which had cruised with the Admiralty flag in 1870. Captain May reports of the 'Northumberland':— Reports of Captains, 1870. Captain May, R.N.

'In the bad weather lately experienced the "Northumberland" proved herself an admirable sea-boat; she laboured less than any wooden frigate to which I have ever belonged, and did not strain in the least. The vessel certainly shipped the top of one sea when lying broadside on to the swell, but I attribute this mishap to her being in that position. In my opinion, this vessel, when caught in a heavy gale, should if possible get up steam at a slow speed; the square sails should then be furled, the after trysail set, and the ship's head placed with the sea three points on the bow. In that position I consider she would encounter the heaviest sea with comparative impunity.'

The Earl of Clanwilliam made a very similar report respecting the 'Hercules.' Admiral the Earl of Clanwilliam.

'I have the honour to report that Her Majesty's ship "Hercules" displayed very good qualities during the late heavy gale off Cape Finisterre; she was very steady; the heaviest lurch was from 12° to 13° with a fierce gale and a very heavy sea, both on the beam. One sea was shipped on the quarter-deck, but I attribute that to my not having sufficient canvas on the ship at the time. But I regret to say she is a most difficult ship to steer under all circumstances, from the large weather helm she carries, without a speed of four to five knots, more especially running before the wind. When the gale commenced she steered so wildly and broached-to so often, that I gave up the idea of running out the gale and hove-to with fore and main trysails and fore staysail, using steam with about twenty revolutions. I believe the battery guns could have been worked and the ship taken into action at any time during the gale, using steam with full power.'

As a resource in a naval engagement, the use of sails must be absolutely dismissed from view. The following authorities may be quoted in support of this assertion. Sails useless in action.

Sir Sydney Dacres: 'No turret ship ought to have a mast. Ironclad ships cannot sail.' Sir Sydney Dacres.

Sir George Wellesley: 'In case of a war I should at once take out the masts; but until that happens, by having the sailing power we are teaching the men to be sailors, keeping them healthy, and making them handy at sea. In case of a squadron lying-to, they would really be better without sail.' Sir George Wellesley.

M. Dislère. *Marine Cuirassée.*

M. Dislère, in *La Marine Cuirassée*, says:—

'Mais ces remarques s'appliquent uniquement à la navigation: pour le combat, les conditions sont toutes différentes. Il faut nécessairement réduire le fardage de la mâture au strict indispensable; il est urgent d'obvier aux graves dangers que la chute de cette mâture peut entrainer pendant le combat. Lors du départ de l'escadre de la Baltique, les navires cuirassés avaient laissé à Cherbourg les mâts et vergues de perroquet, tous les bouts-dehors, les voiles et le gréement correspondant, et cependant l'encombrement des ponts, au branle-bas de combat, était encore considérable. Peut-être serait-il nécessaire pour les cadres de se débarrasser, au moment d'une déclaration de guerre, de tous les *impedimenta* de la mâture: dans tous les cas, pour le combat, il est indispensable de dépasser complétement et d'amener sur le pont les mâts supérieurs et toutes les vergues.'

Guerre d'Escadre.

The same author remarks in *La Guerre d'Escadre*:—

'Quant aux ressources que l'on peut trouver dans la voilure, il ne faut pas songer à alourdir ces navires d'une mâture exagérée, qui, par son fardage, pourrait créer des embarras, quelquefois même des dangers pendant le combat, et comme il est impossible, par suite, de leur assurer des qualités de voiliers, il faut se contenter de ce qui est strictement nécessaire pour tenir la mer: une surface de voilure égale à quinze ou seize fois celle du maître-couple paraît suffisante pour cela.'

M. Marchal.

M. Marchal, in his work, *Les Navires de Guerre les plus récents*, says:—

'Si l'addition d'une voilure reste cependant un avantage pour le cuirassé de premier rang en temps de paix, cet avantage ne se fera guère sentir en cas de guerre. La mâture sera alors réduite à sa plus simple expression, mais il n'en est pas moins vrai que sa présence fait perdre au bâtiment la supériorité de puissance offensive que confèrent au cuirassé sans mâture les champs de tir étendus compatibles avec la suppression des mâts et des haubans.'

Lieut. Eardley Wilmot, R.N.

In the discussion on the Naval Essays of 1878, Lieutenant Eardley Wilmot, himself a successful essayist, gave the views of the younger officers of the service, when he said:—

'As regards the question of masts, I think anybody who has an opinion in favour of masts for a purely fighting ship will see the *disadvantages* of them by comparison between the "Neptune" and the "Dreadnought." They are both lying alongside one another, the "Neptune" a masted turret-ship, and the "Dreadnought" a ship similar to the "Thunderer." In the "Neptune" we have very heavy

masts and rigging, which would circumscribe the fire considerably; they are liable to jam or stop the turrets, and foul the screw in case of being shot away, to say nothing of being less economical in time of peace in proceeding from one place to another, and also decreasing the amount of coal carried. One of the chief advantages of mastless ships like the "Thunderer" and "Devastation," is that they carry almost four times as much coal as the masted ship: the "Devastation" carries 1,700 tons, while the "Hercules" and "Alexandra" can only carry 500 or 600 tons as the outside amount. That, I think, is a very important thing, and when we were in Besika Bay, the "Devastation" sometimes had to supply coal to other ships.'

As an auxiliary to the steam power sails will always be of value. The objections to the present plan of rigging were stated, and an improvement, which would appear fully to deserve a trial, was described by Captain Colomb in the Prize Essays of 1878, and in his special paper 'On Masting and Sails,' read at the United Service Institution in the same year. On the latter occasion Captain Colomb made the following observations showing the results of his experience and investigations:— Captain Colomb, R.N.

'In my essay on the *Development of our Maritime Power*, I have rested the propulsive force of our war ships almost entirely on their coal stowage, and on the means at our disposal for their replenishment with coal in our own depôts. I have proposed that the sail power of our war ships should be reduced to the position of a true auxiliary. We should, I have assumed, build our war ships without any reference to sail power; and, after the design is completed, we should then furnish them with such a rig as should give them the least possible inconvenience in foul winds, and the greatest possible assistance in fair winds.' He went on to say that he had not been at first prepared for the insignificant results which the power of sail exhibited when compared to engines, and quoted the following remarks of Captain Fisher in 1871:—'Masts and sails should be done away with. The weight and room they now represent should be taken by coal. No better proof exists of the wisdom (the economy and efficiency) of doing this than pointing to the example of all the new ocean steamers, amongst the most successful of which are Mr. Holt's. These steamers, built more for cargo than speed, make the passage from Liverpool to Singapore in forty-five days, and they carry ninety days' coal. A paper might be written to prove the actual waste of coal caused by masts and sails in squadron sailing, due to the frequent stoppages and alterations in speed; and it may almost be asserted, as a general rule, that the cost of refitting Captain Fisher, R.N.

exceeds the value of the coals which would have been used in the year's cruise, had steam alone been used.' Captain Colomb then proceeded to give an analysis of the results of steam and sail power during a two years' cruise in an ironclad, ending October 28, 1876. He showed that during that time not more than seven per cent. could be put down as the gross saving of the coal due to the use of sails. He calculated that the weight of masts, sails, and rigging, equal to 520 tons, or more than half the weight of the armour, had led to the consumption of 1,301 tons of coal, while the coal saved by the use of square sails had been but 453 tons. The net loss of coal owing to the sails had therefore been 848 tons. If to this were added some four per cent. for the resistance of the spars when steaming head to wind, it would bring the amount of coal to 1,000 tons, equivalent at an average foreign price to a loss in money of about 1,150*l*. per annum. Turning from the usual peace duties of a man-of-war to the operations of war, Captain Colomb remarks:—'As to the inconvenience of full rig to a fighting ship in action, opinions will no doubt differ. We happen to have an instance before us, by way of experiment, which seems to cut so accurately both ways as to leave the argument just where it stood. The German "Meteor," off the coast of Cuba in 1870, fought the French "Bouvet." The German planted a shell in "Bouvet's" boilers, and observing her helpless condition, ran down to make her an easy prey. But the "Meteor's" wounded masts fell and fouled her screw, rendering her just as helpless as her antagonist. The "Bouvet" then, by the use of her sails, crawled away into neutral waters and saved herself. On this experiment one side will argue that had the "Bouvet" not been provided with a full rig, she would have fallen a prize to the "Meteor," while the other will urge that had the "Meteor" been without rig she would have captured the "Bouvet." I am content to leave these arguments where they stand, observing simply that as each may be maintained with equal force of logic, I prefer to take up the ground put forward in my essay, which would give the "Bouvet" a second chance with her steam. If she had so arranged that a single shell would not have absolutely paralysed her steam power, she might have used her reserved steam power to capture the "Meteor," rendered helpless by her supply of sail power.' As the most suitable rig for ironclads, Captain Colomb proposed leg-of-mutton sails. The total area of these sails for a ship of the 'Audacious' class would be 14,504 square feet, which compared favourably with the area of the present fore-and-aft sails of 9,592 square feet. He calculated that by means of the new rig, 360 tons

of ballast would be saved and utilised for the augmentation of the coal supply.

In the discussion which followed, Sir Spencer Robinson said:

Admiral Sir Spencer Robinson.

'Many of the points touched upon by Captain Colomb I can corroborate in a very marked way. During the time I was at the Admiralty we had repeated trials of ships without masts, and trials of the same ships masted. The comparison was remarkable in the sense that he has laid before you to-day; the loss from masting the ship was extraordinary, and the actual loss of speed at the measured mile in many instances amounted to far more than the five per cent. that Captain Colomb has stated. The only point connected with the masting of ships, and with the increased displacement consequent thereon, that Captain Colomb adverted to, which I do not feel perfectly sure about, is this: it is not always the case that lightening the ship, and diminishing the immersed area of midship section, causes the speed of the ship to be increased, or causes the mileage per ton for weight of coal burnt to be increased. In some instances, though by no means in the majority of cases, quite sufficient is known to make one feel the impossibility of agreeing with the theory that every time you lighten the displacement of a ship, you add to her speed and diminish her coal consumption, because there are so many cases in which we find that ships more immersed, that is, with greater load as it were to drive through the water, greater area of midship section, go faster than they did in their light state, and the reason is not far to seek. Owing to Mr. Froude's experiments, and owing to the scientific analysis and investigation of such gentlemen as my friend Mr. Scott Russell, we are much better acquainted than we were with the resistance offered by the water to propulsion, and have seen that the screw working in deeper water has sometimes a greater propelling and a more efficient power, notwithstanding the greater load that it has to propel. But though I say that there are many instances, and there appears to be a good reason in many cases for what I now say, that the absolute displacement of a ship will not always be the measure of her speed and coal consumption, and that lightening the ship may not absolutely produce the best result in propelling her, yet the advantages Captain Colomb has put before you of removing the enormous weight of two or three hundred tons of masts, rigging, sails, and stores will, in the majority of cases, be found to exist. Even retaining the same amounts of weight, two or three hundred tons applied either in armour, coals, or armament, would give us advantages, of which we are entirely bereft by the application of sail-power. The safety of ironclads has often given us some concern. Doing away with the masts of these ships at once removes all

fear as to the comparatively high position of their centre of gravity The load upon all ironclads is necessarily higher, and necessarily raises the centre of gravity more than it is raised in ordinary ships, and, if we add to that sail-power, we may perhaps place our ships, when their angles of inclination are large, in a dangerous position. By doing away with these masts and yards, we need not hesitate to put our weight exactly where it is most convenient, in order to make a formidable ship for offensive or defensive purposes.'

Captain Tryon, R.N., C.B.

In the course of the same discussion Captain Tryon, R.N., said, 'that having been recently on a cruise in a frigate he thought it would be impossible to do away with sails for cruisers. The results in Captain Colomb's tables were miserably low, being only from four to 8½ knots. In his frigate he could steam 15 knots and more, and sail at times somewhat faster. He thought most naval officers would say, "No masts whatever for an ironclad." They were of little use at any time, and would be in the way on the day of action. But there were times when sails in a frigate, such as he had commanded, were of the utmost importance.'—Sir Spencer Robinson wished to explain that his remarks had reference only to ironclads.—Admiral Vesey Hamilton said that he had the misfortune to be driven on shore, and to have had to throw out his coal. What, then, could he have done without sails? 'There are some very important lines of Transatlantic steamers going out of Liverpool, and every one of these liners is sparred and masted to a very fair extent. I have made six passages across the Atlantic in them, and I found they never lose an opportunity of making or shortening sail. In the Cunard, the Inman, and the White Star lines, we find more attention paid to making and shortening sail in full-power steamers than we do in the Royal Navy. Depend upon it, it is an economic gain to these firms, or they would not keep those sails and make use of them as they do. Not only that, but in going out to the westward in the winter time they never send down the topgallant mast. They say, "The stick aloft makes no difference; it is the sea that brings ships up, and not the wind." I think there is another point in which the use of sails is still beneficial, and that is when we have to make our sailors or keep up their knowledge. We do not want them to be mere drilled machines. In war time, the work the seaman has to do developes his individuality, but in peace time, you want masts and spars for the purpose of drilling them in their own line.'

Admiral Vesey Hamilton.

General conclusions as to masting.

The proposals of Captain Colomb seem an answer to the assertion and the challenge, put forth several years ago, by the late Admiral Halstead, when he said that every square foot of canvas carried by a

screw ship, when steaming, gave, without expense, increased effect to the effort of the engines, but that no sail equipment, specially studied for reducing retardation to a minimum, had yet been adopted in any navy.

On the whole, it is impossible to resist the conclusion that the turret ship lightly rigged is the most powerful type for the line of battle. All ironclad ships when going into action will send down their spars, except the lower masts and yards, and therefore will be completely divested of the qualities of a sailing ship. Masts and yards may, however, be retained, where they do not prejudicially affect the fighting qualities or coal endurance of ships, as auxiliary to the steam-power. A moderate spread of canvas will tend to economise the consumption of fuel; and masts and yards offer great advantages as a gymnasium for the crew of men-of-war, who must be numerous for fighting purposes, but for whom it is most difficult to provide healthful and sufficiently varied employment in an absolutely mastless vessel.

In the largest steamers in the Atlantic trade sails are regarded as a valuable resource in handling ships in gales of wind. In second-class ironclads the rig, as proposed by Captain Colomb, might be modified, square sails being added on the foremast. The square canvas would assist to keep vessels before the wind and sea, when scudding in heavy weather.

Speed of battle-ships.

In all classes of ships, whether for the line of battle or cruising, speed under steam is the primary quality: the manœuvring qualities come next in importance. It should be the aim of the naval architect to secure for his own navy a decided superiority in speed. High speeds are not easily attained in cumbrous and unwieldy ironclads; but in the supreme trial of battle an advantage in speed may decide the issue. Among the officers who have specially studied the manœuvring of a fleet, with reference to the use of the ram, those whose opinions are here given will probably be accepted as high authorities.

Admiral Ryder.

Admiral Ryder, reporting on the diagrams, published by Admiral Boutakov, showing the result of a long series of experiments, which he had carried out in the Gulf of Finland, sums up his conclusions thus:—

A study of the diagrams points out the great advantage—

(1) Of speed.

(2) Of turning power.

A vessel, A, coming up astern, has her opponent, B, if of less speed, at great advantage; there is no escape unless B can destroy A by

firing at her. When A comes close, B dare not turn for fear of re ceiving the blow on her side.

niral rgois. Admiral Bourgois, in his 'Etudes sur les manœuvres des Combats sur mer,' published in the *Revue Maritime* in 1876, confirms the deductions of Admiral Boutakov:—

'1° L'avantage de vitesse est la faculté capitale pour l'attaque, une faculté maitresse qu'il faut obtenir à tout prix;

'2° La faculté giratoire ne paraît venir qu'en seconde ligne; capitale pour la défense, elle n'est pas au même degré précieuse pour l'attaque. Néanmoins, il ne faut rien négliger pour l'avoir aussi étendue que possible. Nos cuirassés ont encore beaucoup à faire sous ce rapport, et la Commission appelle tout particulièrement l'attention sur ce point important;

'3° La faculté giratoire, lorsqu'elle est grande, contrebalance dans une certaine mesure l'avantage de vitesse. Quand c'est l'assailli de marche inférieure qui tourne le mieux et le plus court, l'assaillant plus rapide éprouve des difficultés considérables à lui donner le choc d'une façon efficace; la lutte se prolonge et l'avantage peut rester alors à l'artillerie la plus puissante et la mieux servie, avant que les efforts de l'assaillant pour assurer le choc aient abouti;

'4° Si la grande vitesse et l'extrême faculté giratoire viennent à s'unir dans un même type de bâtiment, il acquiert une supériorité décisive dans le combat par le choc.'

George torius. In the debate at the United Service Institution on Mr. Barnaby's paper on Modern Ships of War in June 1872, Sir George Sartorius, the leader of the movement in favour of the ram, as the great naval weapon, spoke as follows:—'The most important requisite for the ram is speed. What can the strongest man do if his enemy can always avoid his blows? Such a vessel may have the charge of a convoy of transports, and they are met by an enemy, ram or otherwise, but very rapid and handy; she could get in amongst the convoy, without giving the slow and heavy protector the chance of getting a shot at the interloper. To use its prow of course is out of the question, and could such a ram escape destruction from the attack of two smaller but swifter rams? The efficient ram must have very great speed and great handiness. This is an important fact for us always to bear in mind.'

miral 18. Another fine officer of the old school, Admiral Rous, in writing to the *Times*, said: 'Speed is everything. A ship of war ought to be able to run 16 knots, and they would destroy any mercantile vessels in the presence of slow ironclads.'

The late Controller of the Navy, in a memorandum of June 21,

1878, wrote as follows:—'Speed and coal endurance are what is insisted upon. All else is of secondary importance, if we are to protect our commerce and keep the highways of the seas.' Sir Houston Stewart

1. In duels, and probably to a large extent in fleet actions also, when a ship can use the ram, and in conjunction with it the broadside torpedo on either bow, speed is more valuable than handiness. For, provided she can get up to her adversary, she can be sure of being able to employ *one of the three weapons against her.*

2. This consideration makes speed more important than handiness as a means of *defence* as well as of offence.

3. So far as an opinion can be formed from the performances of actual ships, speed cannot be obtained in short ships without large engine power. To economise power, *i.e.*, to reduce the size and cost of machinery, and the consumption of fuel, long ships have an advantage over short ships.

4. When there is armour from end to end, either complete or as a belt, long ships are wasteful of armour, but when the armour is centralised this is not so.

5. When it is designed to defend the stability and buoyancy by armour, short ships have the advantage in economy of armour. But when it is designed to protect only *vital* parts, by an under-water deck and a citadel, this is not so.

6. The 'Ajax' class may be lengthened to 350 feet with advantage, if by doing so the speed can be increased to 14½ knots instead of 13 knots with the same engines, the coal endurance being raised to that of the 'Devastation.'

7. This class, either as at present arranged or lengthened as suggested, will be suitable not only for European warfare, but for naval centres on foreign stations.

8. The cruising ship gives up the powerful *protected* battery and avails herself of a still higher speed (15 to 16 knots) in *order to employ her ram and torpedoes against battle-ships when that may be necessary.* She is armed with unprotected armour-piercing guns and light guns, but with very few of them, so as not to *employ many men about the unprotected decks in action.*

9. We thus find two classes each, say, 350 feet long, but one much wider than the other. Both are protected by under-water decks and heavily armoured conning stations; both are armed with rams and with bow torpedoes on each side; both have twin screws and protected steering-gear; both are armed with guns against armoured and unarmoured ships, but with protection for the guns in the slower ship only.

The cruising ship would have a light rig manageable by a small crew, and the battle ship would have no sail.

M. Dislère. M. Dislère, in *La Guerre d'Escadre*, does not entirely concur with Sir Houston Stewart in his appreciation of the importance of coal endurance; arguing that some reduction in the supply of coal may readily be assented to, it being a matter of indifference in the day of battle how many tons of coal are stored away in the bunkers. In a naval engagement, as he contends, it is the number of projectiles which will be of vital consequence. It is necessary, therefore, at all costs to accumulate in the form of guns the weights saved, whether in coal or armour.

Captain Hon. E. R. Fremantle, R.N. The author of the Prize Essay of 1880, Captain the Hon. E. R. Fremantle, insists most strenuously on the importance of speed, more especially in a duel between single ships:—

'(1) A high speed, if not the highest speed, should be maintained.

'(2) Speed is of even greater moment to a ram than handiness or turning power.

'We have treated of the ram as the most important, indeed almost the sole weapon.

'A ship with less speed and inferior turning power to another, can only expect to be saved from being sunk by a lucky shot, which cannot be admitted as a prime factor in the problem.'

On uniformity of speed. Sir Howard Douglas. Where ships are required to act together as a fleet, uniformity of speed is not less necessary than the capability of steaming at a high rate. Sir Howard Douglas, in his *Naval Warfare with Steam*, makes the following observations on this subject:—

'If the steam power of the several ships of the line forming a screw fleet be not uniform, the speed of the whole fleet must be reduced to that of its slowest ship.'

Sir Howard Douglas referred to the incidents which occurred at the battle of Camperdown, as an illustration of the importance of securing uniformity in the sailing and steaming qualities of a fleet. 'The inconvenience arising from an inequality of speed in the ships under his command was seriously felt by Lord Duncan in approaching the Dutch fleet off Camperdown, when a considerable time was lost in the attempt to close up and reform the order of battle; the Admiral being obliged to signal his good sailing ships to shorten sail in order to enable the others to take their stations in line. There not being time to do this correctly, the British fleet was in a very disunited state at the commencement of the action.'

No officers have had the same long practical experience of naval warfare, since the introduction of steam, as the officers of the United

States Navy. When consulted by the Secretary, as to the best type of fighting ships, Admiral Goldsborough, representing the general opinion of the Navy, replied: 'Velocity, involving the capacity of making the vessel a terrific projectile, of turning rapidly, and of avoiding hostile demonstrations, whenever necessary, is of such primary importance that insufficiency of speed is to be regarded as fatal to efficiency.'

Admiral Goldsborough, U.S N.

The French claim for their ships superior speed, and much greater coal-carrying capacity than we have succeeded in obtaining. It is worthy of consideration how far these assumed advantages have been realised; for if they have been obtained without sacrificing more important considerations, then we ought not to allow our ships to continue inferior in these particulars to those produced by the French constructors.

Speed of French ships.

The conclusion to which we are led from this concurrence of high authorities must be strongly in favour of great qualities of speed. The first-class fighting ship should be capable of steaming at least 16 knots; the auxiliary rams 17 knots, the attendant torpedo vessels 20 knots.

General conclusions as to speed.

The proper position for the officer in command of a ship or a squadron in action is a point of much difficulty and of urgent importance. The necessity of giving as much protection as possible, while securing a clear view of the field of battle, were strongly urged by a writer in *Fraser's Magazine* of February 1878:—

Conning stations.

'It will be seen that upon the judgment and nerve of the officer in command will now, more than ever, depend the issue of an engagement. The speed of the ships, the necessity of closely watching every movement of the enemy so as instantly to make the proper counter-move, the absolute need of prompt decision, will prevent a moment for reflection or consultation. The helm and the engines must be under the captain's instant control. He and those by him on deck will alone be able to see the enemy at the frequent times when he is obscured by smoke from the battery below, and to distinguish between friend and foe; and his quick perception will be requisite to determine the proper direction and range for his guns, as well as to avoid firing into friends.

Fraser, February, 1878.

'The extreme importance of the life of the officer in command of the squadron so long as the battle lasts, must also be apparent. In the old wars, the skill, judgment, and determination of our naval commanders were chiefly exhibited by the manner in which they sought out their adversaries and brought them to battle. Hostile fleets were

sometimes in sight of each other for days—calms, light winds, or fogs preventing their approach—each commander endeavouring by skilful seamanship to gain the weather-gage. But, the action fairly commenced, there was little manœuvring—it was hard fighting; the ships were laid alongside an enemy, and the valour of our sailors settled the matter. If the captain were disabled, the duty of his successor was simple and self-evident; if he were incompetent, his deficiencies could be made up by his principal officers; if he lacked courage, his men supplied the want. Nelson's genius had made all the necessary dispositions for battle both at the Nile and Trafalgar long before the action commenced; the captains had only to steer their ships for their allotted adversary, and the rest was done by the crew. Had Nelson been killed by the first shot fired at Trafalgar, the issue of the battle would have been the same. But how different now! From the beginning to the end of an action rapid and constant manœuvring will be required; the ships must be kept firmly in hand and skilfully guided; all the best experience of the Admiral will be in constant request, and should he be killed or disabled at a critical moment, the consequences would probably be most serious. It is not too much to say that the result of a naval engagement in these days will depend entirely upon the skill of the superior officers, in default of which the courage and discipline of the crews will avail little.'

ielore: rva- from *uerre adre.*

The author of *La Guerre d'Escadre* concurs with the writer in *Fraser*:—

'Nous pensons que, sans en arriver à cette protection peut-être exagérée, il est indispensable d'abriter le commandant contre la fusillade et les éclats d'obus; nous voyons à cela deux raisons: la première c'est qu'il faut mettre entre les mains du chef le gouvernement de son navire, ou tout au moins sous sa surveillance directe la personne chargée de gouverner; il est donc indispensable de reporter la roue ou les rênes du servomoteur sur le pont, là seulement d'ailleurs où le timonier verra devant lui, et par suite de les protéger; en second lieu, si la supériorité matérielle est beaucoup, ce n'est pas tout: il est difficile de remplacer dans un combat le commandant qui vient de succomber; il est d'ailleurs une autre raison supérieure encore qui tend à lui assurer un abri: c'est que, s'il tombe au milieu d'une évolution, nul, pas même l'officier placé à côté de lui, ne pourra continuer la pensée disparue et profiter, suivant l'impulsion première, de cet instant peut-être unique dont doit dépendre l'issue du combat.'

I venture to suggest that the problem will be solved by providing

a crow's nest at the mast-head, armoured sufficiently to keep out the projectiles from the Hotchkiss gun, and communicating by telegraph with every part of the ship. Admiral Farragut always selected the mast-head as the position most suited for directing operations. A clear view over the surrounding smoke would give an immense advantage to a captain, in the endeavour to inflict or avoid the blow of the ram, or to seize the opportunity for the discharge of the torpedo.

Battle-ships should be fitted with an armoured crow's nest.

Circular ships.

The question of form is intimately connected with the speed required in fighting ships, and a round form offers the greatest advantages with reference to protection by means of armour. With a given weight of armour a more effectual protection can be given to round ships like the 'Popoffkas,' than where the elongated and more shapely outlines are retained, which have hitherto been adopted by naval architects. For these reasons, where it is desired to give complete protection by armour, Sir Edward Reed has urged that the naval architect should take his departure rather from the circular form than the parallelogram, introducing such modifications only as may seem to be necessary with reference to the exigencies of navigation.

The circular form protected with the least weight of armour.

The arguments for the round ships were lucidly explained by Sir Edward Reed in his paper, read on March 22, 1877, at the Institution of Naval Architects, on 'Citadel Ships':—

Sir E. J. Reed, K.C.B., I N A., March 22, 1877.

'I will presume that the days of mere "armour-belted" ships are passing away; that, however torpedoes may be best encountered or resisted, part of the change that they will force upon us is a much more extended and effectual preservation of the bottom of the ship from attack by means of armour plates; and that as an extreme view of the case is often very instructive, we may with advantage assume for the moment that the whole bottom surface of the ship stands equally in need of defence.

'Here, then, we have before us two great and ruling objects to accomplish, viz.—1st, that economy of armour, which, as armour increases in thickness, must press us more and more to reduce the armoured surface to the lowest possible amount; and, 2nd, to so form our armoured citadel that it will possess great stability in proportion to the amount of armour carried by it. The circular form possesses both these advantages in the highest degree. . . Of all circumferences of given length the circular is that which embraces the largest area. . . . Some ends of ship-shape character should be given. . . . But there are many reasons why we should, in proposing citadel ships, well consider the circular form as our form of departure.'

Similar views were advanced by Sir Edward Reed in a paper on the 'Modifications of the last Twenty Years,' read before the Society of Arts:—

Modifications of the last twenty years.

'As the weight of hull becomes more and more great, form becomes of less importance. You can better afford to drive a thick hull than a long and heavier ship with the same power.

'While the bottom of the ship was free from danger, there was a great tendency on the part of builders to go down deep into the water, and to get their buoyancy in that part of the ship which was free from exposure to shot and shell. But, the torpedo having now come into use, we are prohibited from carrying our ships deep down into the water. Some of our ironclads have drawn 27 feet. We have to pass away from that, and to encounter the loss of propulsive effect which we should otherwise receive.

'In view of the power of the effects of the torpedo, I have come to the conclusion that while in existing ships internal subdivisions and modifications of stowage must be resorted to as far as possible, as regards the future no more such ships must be built. Small ironclads of great breadth and short length can be made so handy as to find, in their own agility—associated with great modifications of form, which are necessary even for them—sufficient security against torpedo attack.'

The objection to the circular form consists in the difficulty of securing a satisfactory rate of speed without a disproportionate application of steam power. Economy of power is not the first consideration in a vessel of war, but coal endurance is of high importance, and a ship without speed cannot bring her fighting power to bear on a weaker but more nimble adversary.

The 'Livadia,' lately completed for the Emperor of Russia, presents the fullest development of the circular form which has hitherto been attempted. At the trial trip in the Clyde a speed of sixteen knots was realised. But in order to attain to this result, the engines were called upon to exert no less than 12,000 indicated horse-power. Such an expenditure of power in a vessel of 4,000 tons is sufficient to show that the round form cannot be adapted to commercial purposes. Where, however, protection by means of armour and evolutionary qualities are the primary consideration, the objections to the circular form on the ground of economy of fuel are comparatively unimportant. The sea trials of the 'Livadia' have not as yet been satisfactory. A report by Captain Verkhovsky on the cruise from Glasgow to Ferrol has lately been published in an official Cronstadt paper. The following summary of this document

is taken from the *Broad Arrow* of December 4:—'Captain Verkhovsky was at the head of the committee of scientific officers appointed to accompany the "Livadia" to the Black Sea. His statements may be classified and condensed as under:—

'I. The waves struck the nose of the ship so violently that the shocks could be clearly experienced by all on board.

'II. The usual mode of lessening such shocks by reducing the speed was wholly unavailing, the effects being as strong at two and a half knots as at eight.

'III. The water rushed into the rents in the yacht's bottom in such volume that the pumps could not keep it under.

'IV. It would have been impossible to have gone beyond Ferrol in the condition in which the ship found itself.

'His conclusions are:—(1) That the "Livadia" is wholly unfit for sea voyages; (2) that the hull needs strengthening with a coating of wood and a sheathing of copper; (3) and that structural alterations are needed to qualify the "Livadia" type of vessel for service at sea.'

It is certain that circular ships would be valuable for naval operations in the Baltic, in the Mediterranean, in the Red Sea, and for coast service generally in all parts of the world. In proportion to the armament the cost should be much more moderate than that of any ships of the usual elongated form. The circular ships would have the immense advantage of complete armour protection, and a large expenditure of fuel would not be a serious objection when the operations were confined to European waters.

Barbette turrets.

The barbette system of mounting has been gradually adopted by all the maritime Powers of the Continent. Until a very recent period it was not viewed with favour by the English Admiralty. In this, as in many other questions connected with armoured shipbuilding, the constructors have been ready to adopt the ideas of their rivals; but have been kept in check by the naval authorities. In the main it has perhaps been well for the navy that innovations have been discouraged. We have sometimes neglected the use of valuable inventions, but we have saved a vast expenditure on costly and abortive experiments. The hesitation we have so often shown to accept novelties in naval architecture has enabled foreign Powers to run us hard in the race; but we have yielded at last to the conclusive evidences of experience, and in the main may claim for ourselves that our shipbuilding has followed a course of steady progress, and that we have succeeded in producing some noble examples of every type which has been introduced into our navy.

Enclosed and barbette towers.

In the 'Collingwood,' lately ordered by the present Board, the barbette turret, which was a novel feature in the British navy in the original 'Téméraire,' is to be retained. The following opinions on the relative merits of the barbette tower and the enclosed turret have accordingly been brought together to assist in the consideration of the question.

Mr. Barnaby.

Let us consult in the first place Mr. Barnaby's paper on the 'Hotspur-Glatton' experiment, read on March 3, 1873, at the United Service Institution :—

'Taking the number of rounds per gun at three in five minutes, it is said by many persons that in an action this would be also the number of rounds per turret, as the two guns would nearly always be fired together. If this were so, that would be little more than one discharge per minute from the turrets of a ship like the "Monarch" or "Captain."

'Having settled for ourselves what we will estimate the rate of firing to be in a turret in an action and the risk of missing, let us now bring in the further consideration that to protect two 25-ton guns as they are protected in the "Glatton," you must devote the weight of six other pairs of 25-ton guns to make the turret—*i.e.*, given fourteen 25-ton guns, you must take the weight of twelve to cover the other two; or, to put the matter more fairly, given two pairs of 25-ton guns, with carriages, slides, and full chase allowance of shot, shell, powder, and stores, we must take one pair of guns and its ammunition to make a turret for the other pair, so that the luxury of a turret armament, as compared with unprotected guns, obliges us to give up half our guns and ammunition. Observe I do not compare turret-armour with broadside-armour; I am simply showing what we have to pay for armoured defence on the turret-system in actual weight of ordnance.

'I will ask you now to cross the Channel and see what our quick-witted neighbours are doing; and I must say of the French naval designers, that in my opinion they are second to none in ingenuity, skill, and enterprise in these matters.

'Now, how many turrets of the "Royal Sovereign," "Monarch," "Captain," and "Glatton" type has France introduced into her navy?—Not one.

'I ask myself why this is, and I imagine their answers to be:—

'1st. We have no ships in which we should think it wise to dispose a weight equal to that of the guns and their ammunition as a cover for such guns.

'2nd. When we desire to fire at an enemy, we like to see him,

and we stand a better chance of doing so when we and our gun are not shut up in a box.

'3rd. In a masted ship your turret does not give an all-round fire; you cannot fire either ahead or astern.

'We prefer a plan which is about half the weight of yours; in which we can always keep our enemy in sight, and fire when we can make sure of hitting him: in which we are not embarrassed with smoke to the same extent as a turret is, and in which we can fire right ahead and right astern. That plan is the "barbette battery."

'According to what I assume to be the French view, which I have placed before you for consideration, every masted *turret* ship must necessarily be an extravagant ship, *i.e.*, she must be weak for her size and cost.

'Persons who take this view would admit the success of the "Monarch," for example, but would consider that some 400,000*l.* is too much money to pay for a ship with only two turrets and only 7-inch armour for the protection of her hull.'

In the course of the discussion which followed the reading of Mr. Barnaby's paper, the late Captain Goodenough said:— Commodore Goodenough.

'I wish to bear my testimony in entire approval of almost everything Mr. Barnaby has said, and especially of the design which he has put forward. I have had the advantage of being recently in France, and I, therefore, may be in a position to explain to the meeting some of the peculiarities of the French ships which carry these barbette *towers*, as we may prefer to call them, in opposition to *turrets*, upon their decks. The French ships have a battery which, we may say, is more or less like that on the main deck, and the towers which they carry are on the upper deck, on the four angles of the battery, projecting slightly from the ship's side, so that the two foremost guns get a fire almost right ahead and to a considerable angle astern; the two after guns almost right astern and a considerable angle ahead; the rigging of the foremast and mizenmasts being brought down to plates, tied under the main deck beams. There are drawings to be seen of one such arrangement of the battery in the *Revue Maritime* for last July or August, with a very excellent memoir, by Captain Baron Grivel, who commanded the "Océan." I have met a great number of officers of the French navy who have commanded these ships, and, without a single exception, they expressed themselves most entirely satisfied and pleased with the barbette guns. They speak particularly of the very large offensive power that it gave them; that it not only gave them a large arc of fire, but I was very glad to note that they dwelt upon

the possibility of seeing the enemy at the points of your sights th whole way round, even when you had an obstruction in the shap of rigging which prevented firing, instead of having been at on moment hidden from you by the superstructure forward, and th next moment suddenly appearing in sight, through a narrow port where your eye is almost blinded with light, and where you are no in a position to recognise the presence of an object till it has bee for some seconds within your range of view. Of course there is disadvantage in sustaining a close action, at fixed distances, and i a single spot, in a ship with such barbette towers, and I think tha this points out the necessity of our having distinct ships for tha particular service. That is to say, you engage a battery and you are going to anchor at a fixed distance from that battery, and t engage it for any length of time; it is evident that for such a purpose you must resort to the closest armour-plating you possibly can have, and that you must protect the men who are going to worl the guns, otherwise they will very soon be put out of action and you vessel may be obliged to move, or will have to be supplied with fresl men. But where you have a sea-going ship of that description there is no reason whatever, so far as it seems to me, why you shoul not discard all that weight of armour which you carry about the gur for the defence of the crew, and employ it either to increase you speed or to increase your coal-carrying power, or the armour on the belt.'

With reference to the general question of protection for guns and their crews, the report of the Secretary of the United States Navy, 1875, contains the following communication from Admiral Porter, dated November 6, 1879:—

Admiral Porter, U.S.N.

'I believe that iron sea-going ships of war will ultimately be built without any armour on the topsides; that the hull for three feet above and below water and the decks will be made as far as possible impervious to shot, but that all the upper works will be ordinary iron, through which the shot will be allowed to pass.

This, it is true, will not afford perfect protection to the ship's company in action, as shot passing through the thin iron will knock down everything in its course; but this is better than having a turret of 15 inches thickness crushed in upon a crew, and I believe men will fight longer and better on an open deck, where they can see their enemy, and know what is going on.

'It is very demoralising to be shut up in a turret and have men killed by concussion, with the likelihood of a stray shell coming in at the port and killing all hands. A few years ago, officers and men

would scorn such shelter, and I believe at this day that almost anyone would rather take his chances on the open deck.

'Uncovered guns run little risk of damage by shot at sea. When a vessel is rolling, not more than one shot in twenty takes effect, and there are no serious objections to guns on the open deck, provided they are covered from grape and canister. Bulwarks could be thickened to extend a little over the height of the gun, but only in front of it.'

M. Marchal.

M. Marchal, in his article entitled 'Tableau et Classement des Marines Militaires,' in the *Revue Maritime* of February 1878, remarked:—

'The gun itself does not stand in the same need of protection by armour as the mechanical arrangements by which it is worked. The gun is not highly vulnerable and is not very easily hit. It may, therefore, be left without protection. The mechanism of the gun-carriage, on the contrary, which it will be impossible to work should it be injured in the smallest of the working parts, is delicate and incapable of resisting the blow even of a shell of moderate dimensions. To protect this machinery, therefore, is a matter of primary necessity, especially in the case of the large guns now mounted in board ship, each of which represents so considerable a proportion of the fighting strength of the vessel. We have observed that light guns do not require armoured protection. If the armament of a ship consisted solely of guns of small calibre, armour would be unnecessary for the guns.'

***Broad Arrow*, June 5, 1880.**

The *Broad Arrow* of June 5, 1880, contained a valuable article on the barbette question, from which the following extract is taken:—

'In 1873, when the "Téméraire" was designed, the muzzle-loading system prevailed both in our own and the French navies. To load at the muzzle a gun which is mounted and fired *en barbette*, involves some considerable labour, especially when the gun is very heavy. Mechanical appliances can be, and indeed have been adopted, whereby the labour and difficulties of the operation are minimised; but after all it will be evident that whatever may be the decision with regard to the advantages or otherwise of the barbette system with muzzle-loading guns, the case is very much altered when we experiment with breech-loaders. The latter is, in fact, as we shall presently see, much better calculated to develop the full advantages of the barbette system. It is on this account, we suppose, that the Italians have decided to place barbette towers in the "Italia," rather than repeat the close turrets which are found in the "Dandolo" and "Duilio." The circumstances attending the recent explosion of the

100-ton Armstrong gun on board the latter vessel are, we believe, to be credited with bringing about this decision of the Italian Government. We also consider it not unlikely that the same circumstances have had an influence on the minds of their Lordships, resulting in the adoption of the barbette system in one of the new ironclads. Twelve months ago, when discussing in this paper the heavy gun question, we said that the generation of poisonous gas in the powder chamber of the breech-loader was almost the only objection to its use in turret ships. The gases generated within a muzzle-loader escape out of the port-hole, whereas in the case of a breech-loader, directly the breech is opened a large quantity of the most stifling and poisonous gases at once escape into the turret. The use of the modern slow-burning powder tends rather to increase the evil attending this circumstance. It has therefore been feared that, notwithstanding all the advantages of the breech-loading system, a consideration for the safety of the gun's crew against suffocation or poisoning would preclude the use of such guns in turret ships. There is probably great weight in this objection. Even before the explosion of the "Duilio's" gun the air within the turrets was so vitiated as to be unfit for respiration, and had not a portion of the turret roof been continually lifted it is probable that the air would have soon become so bad as to render it uninhabitable. The consequences attending such a state of affairs during the heat of an action, when it would be most likely to occur, are sufficiently obvious. The remedy is evidently found in the entire removal of the roof, and firing the gun over the top of the tower instead of through a port-hole. In that case a complete circle of range can be obtained without moving the turret itself. This is, in fact, the barbette system.

'It will therefore be seen that, although it was fairly open to question whether the barbette tower was superior to the revolving turret when muzzle-loading guns were employed, with the adoption of breech-loaders the barbette system becomes a necessity. Nor does the advantage consist only in regard to the points we have enumerated. The barbette tower dispenses with revolving machinery, steam-engines, and other details involving weight, and therefore avoids taxing the vessel's carrying powers by a considerable amount. The tower need not be much over a man's height, and, provided its diameter is not great, will require no other roof protection than a bullet-proof screen, which may be raised several feet above the top of the towers. Indeed, as a general rule, these screens may be dispensed with, for it can only be when in close action with a rigged ship that they would be needed. But in our opinion the days of

close, hand-to-hand encounters are ended, except so far as regards such momentary shocks as ramming. Another advantage of the barbette system is found in the fact that with it there is no such danger possible as that of the turret becoming jammed by a shot, nor are there points of discontinuity, and therefore weakness, in the wall of the barbette such as exist at the port-holes of the turret.

'It will therefore, we believe, appear that upon the whole the advantages of the barbette over the turret system are so great when breech guns are employed that the former will in future prevail. We say this upon the supposition that we are to have breech-loading guns for the Royal Navy. It is true that such a decision has not yet been arrived at, but we believe that it is inevitable. The fact that Woolwich has been compelled to yield so far as to manufacture a trial breech-loader is sufficient evidence that right has sufficient power behind it to ultimately prevail. For the breech-loader we must have barbette towers in our ships and uncovered fortifications on land. For casemate batteries and covered fortifications generally, it will, we fear, be necessary to continue the use of some form of the muzzle-loader. At all events the trials of the "Duilio" and such other experience as we possess on the subject point to that conclusion.

'By adopting the barbette system in only one of the three new ironclads it would appear that the members of the late Board had not fully made up their minds upon the question of breech *versus* muzzle-loaders. We trust, however, that ultimately we shall see that system adopted in the others of the class, and, if not too late, applied also to the "Colossus" class.'

Where the guns are mounted in turrets *en barbette*, the gunners obtain a clearer view of the horizon than where they are mounted in closed turrets, and much weight is saved which can be utilised for the protection of the water-line and the vitals of the ship. It is an obvious objection to the barbette that the gunners are exposed to the fire of the Hotchkiss guns, mounted in the tops, which would become most deadly at close quarters; but protection from such an attack may be given by means of bullet-proof shields or armoured flying decks.

H.M.S. 'Collingwood.'

The armoured battle-ship 'Collingwood,' ordered at Pembroke, is the first example of a barbette ship in the British navy. The special features in this design are described by Mr. Barnaby in the following memorandum :—

'This ship differs from earlier unmasted battle-ships in the English

navy ("Devastation," "Thunderer," "Dreadnought") principally in the following particulars, viz.: —

'1. Only the central part of the ship at and below the water-line is armoured, an under-water deck being substituted for side armour at the ends of the ship.

'2. The ship is to be armed with heavy breech-loading guns.

'3. These guns are not mounted in revolving turrets, but on turn-tables revolving within fixed towers, so that the guns are always exposed to view above the rim of the tower.

'4. The measured mile speed is set one knot in advance of that which is usual in first-class ships.

'In respect of 1, the arrangements are of the same nature as those in the "Inflexible," "Colossus," and "Majestic," &c., *i.e.*, the ship has buoyancy and stability to enable her to continue an action after the ends have been waterlogged.

'In respect of 2, she will be like the ironclads in the French and German navies, only that the guns will be lighter and less powerful than some which are designed for recent French ships.'

In respect of 3, the mode of mounting the guns is that which is general in the French and German navies, with breech-loading guns. As compared with the turret it has the disadvantage of exposing not only the chases of the guns, but also the breeches to fire, and the few men required as loaders are not nearly so well protected.

But, on the other hand, it presents the advantages of giving a better range of vision, a greater height of gun above the water, and a much smaller surface requiring to be protected by armour.

Taking two ships of the same size and displacement—the 'Colossus' and the 'Collingwood'—the one to be armed with breech-loading guns in turrets and the other as described above, it appears that the latter ship can have the superiority of one knot in speed, and can carry her guns more than twenty feet out of water instead of twelve feet.

In addition to the main armament of four 43-ton guns, each ship carries some additional armour-piercing guns not protected by armour. Of these the 'Colossus' carries two, or perhaps four, not protected against musketry, the 'Collingwood' six, all protected against musketry, and also against raking shell fire.

It may be convenient to give the principal dimensions of the 'Collingwood,' which, as it has been stated, differs from the 'Colossus' solely in the methods of mounting the guns, and in a superiority in speed of one knot.

H.M.S. 'Collingwood.' Statement of Dimensions, &c.

Length between perpendiculars		325 feet
Breadth, extreme		68 feet
Draught of Water	Forward	25 ft. 3 in.
	Aft	26 ft. 3 in.
Displacement, in tons		9,150
I. H.-P. of engines		7,000
Estimated speed, in knots		15
Coals, in tons		950
Complement of men and officers		345
Armament		Four 4-ton guns Six 6-inch guns
Thickness of armour (maximum)	On sides	18 inches
	On bulkheads	16 inches
	On barbettes	24 inches
Thickness of deck plating		3-in. steel

Auxiliary vessels.

While it is doubtless a wise policy to devote the resources at the disposal of the navy mainly to the first-class ships, a fleet composed exclusively of heavy ironclads can scarcely be considered perfect for the various duties and services the navy may be called upon to perform. The shipbuilding policy of England should be conceived in a comprehensive spirit. It should include every naval weapon and every type of ship which promises to be of service in time of war.

The first-class ironclads will require the support and co-operation of a large and varied array of auxiliary vessels, to which they will serve as a base of operations.

Admiral Porter, 1874.

In his annual report for 1874, Admiral Porter does not recommend to Congress to build monster ironclads, with a high freeboard, protected by thick plating, but to build thirty monster rams of great speed, and at least fifty iron torpedo boats of good speed, and not less than 100 tons each.

Admiral Jurien de la Gravière.

In his essay on 'Naval Tactics,' published in the *Revue Maritime* of March, 1877, Admiral de la Gravière urges especially the great importance of auxiliary vessels:—'Nous avons cuirassé nos navires et rendu de nouveau nos canons sans effet; nous en reviendrons nécessairement à l'emploi des moyens qui suppléaient autrefois le canon. Nos brûlots s'appelleront des bâtiments-torpilles.

'Nous verrons donc encore des armées navales s'observer, se menacer longtemps avant de se décider à se joindre, puis tout à coup se ruer l'une sur l'autre, se traverser, se heurter, se confondre. En avant seront rangés les navires de haut bord, ceux qui seront de taille à combattre par le fer et par le choc, qui auront été construits pour

[illegible] parmi [illegible] dans [illegible] et [illegible] C'est à ce [illegible] droit [illegible] si quelque [illegible] conduisant [illegible] contrarié par le [illegible] mais [illegible] rapides et maîtres [illegible] le seul [illegible] pour ouvrir dans le [illegible] de plusieurs mètres, il y aurait péril sérieux [illegible] délicate et précise à faire pour lui échapper. [illegible] elles, dira-t-on, combien n'en coulera-t-on [illegible] combien n'en écrasera-t-on pas sous sa [illegible] facile qu'on ne pense. Le corps de [illegible] là pour protéger la flotille. Les [illegible] Le meilleur amiral était autrefois [illegible] couvrir, les placer dans la position la [illegible] au moment le plus opportun. Il en

The subject under consideration formed the main theme of Mr. Barnaby's paper, read at the Institution of Naval Architects in the session of 1876:— Mr. Barnaby, I.N.A., 1876.

'Looking at the relative distances within which the gun, the torpedo, and the ram are operative, and the risks of failure in striking with them, the gun occupies the first place, and the ram the last, as instruments of naval warfare. (2) From this it follows that ships built only for ramming forego the use of two more important weapons. That a ship built only for torpedo service is better than a ram, but is still inferior to one built for service with guns only. The advantages of combinations of these weapons follow the same rule. (3) That while the gun is, on the whole, the superior weapon, it can be resisted more easily than either of the others. If it were as difficult to resist the blow of the gun as it is the blow of the torpedo or the ram, naval warfare would cease to be practicable. (4) The growth of resistance to the gun encourages further increase in the power of the gun, and there appears at first sight to be no limit to this increase. The limit will probably be found in the cost of putting the gun afloat with proper protection for it and proper speed. The cost will be reckoned in view of the exposure of each such gun to loss by the power of the ram and the torpedo when they can be brought within the proper range of their operations. Some people appear to suppose that the constructors of the navy are only just becoming alive to the dangerous nature of the torpedo, and its probable effect upon the ships. I may, therefore, perhaps be allowed to refer to an opinion expressed on this matter in January, 1867, at the Institution of Civil Engineers, by an Admiralty Constructor, *vide* Vol. 26 of *Transactions* of that Institution. He said: "It must be borne in mind that, however thick the armour, the bottom of the ship was left as weak and defenceless as ever. Torpedo boats made proof against almost any firing that could be directed against them could be carried in sea-going ships, and, doubtless, would be so carried and employed. In view of these new and undeveloped but terrible agencies, it was desirable not to create a large fleet like that recommended, at the cost of many millions of money, which, although secure from gunpowder above water, might easily be rendered obsolete and useless, because undefended from gunpowder fired from beneath." The author of these remarks was myself. (5) The torpedo can be made within the proper range of its operations irresistible. (6) If the blows of the torpedo are to remain irresistible when fairly delivered, it remains to be considered in what manner and to what extent the attack can be met, because it would appear

[illegible] and armour [illegible] in the torpedo-ship [illegible] and enable her to come down [illegible] and deliver her fatal blows; [illegible] armour. [illegible] rams or torpedo [illegible] though involving the [illegible] of the attacking vessels, would still [illegible] (7) The possibility of such [illegible] torpedo ships, or by numerous un- [illegible] expose the costly armour-clad ships [illegible] alone. The assailants [illegible] before they could get within striking [illegible] armed like the attacking vessels [illegible] which may take, like them, the chances [illegible] I contend that the defence against the ram and the torpedo must be sought for not in the construction of the ship alone or mainly, but also and chiefly in the proper grouping of the forces at the points of attack. Each costly ironclad ought to be a division defended against the torpedo and the ram by smaller numerous but less important parts of the general forces. (8) If the foregoing considerations are correct, there is still place in naval warfare for costly ironclads with thick armour and powerful guns. There is place also for association with them of unarmoured vessels armed with the torpedo and manned by brave men. (9) There is work also for lightly armoured and partially armoured ships, because any armour obliges the adversary to increase the power and diminish the number of his guns.'

Sir Spencer Robinson

In the discussion on Mr. Barnaby's paper, Admiral Sir R. Spencer Robinson said: 'No suggestion more valuable for the purposes of war has been made by any person within my knowledge than the able suggestion which has been made by Mr. Barnaby, that the true mode of defending our heavy ironclads from these attacks is by the counter attack of torpedoes and rams. No fleet, therefore, can be considered a fleet, and in my humble opinion no ship like the "Inflexible" can be considered a ship of war, until she has her attendant rams and torpedoes to meet those attacks to which she is sure to be subjected.

'I am quite satisfied also that Mr. Barnaby has hit upon the right plan of defending such ships from the attacks of torpedoes. It is by counter attack that you must succeed, and not by piling mountains of iron upon the sides of your ships.'

Sir E. J. Reed took a prominent part in the discussion. He also

approved highly of Mr. Barnaby's proposal:—'The proper way to defend armoured ships from rams and torpedoes is by auxiliary vessels; and I must say that this idea seems to me to be likely to prove important from what I have found to be generally a very good reason, that is, that there is a sort of concurrence of opinion setting in that direction.' Sir E. J. Reed.

Mr. J. Scott Russell said:—'Mr. Barnaby deserves great credit for the manner in which he has developed that large question that a ship is not a fleet, and that a dozen of ships is not a fleet, and that a dozen of the strongest ships is not a fleet, and that nothing is a fleet but a series of ships of different classes, all grouped around some other ships, and each performing some special function of its own in that service. All the best naval men I know in all countries are of that opinion.' Mr. Scott Russell.

The smaller vessels, which are to be combined with the first-class ironclads, can only be made effective by insisting absolutely on the principle of specialisation. Rams will be required to support the attack of the larger ships. The repeated charges of an 'Inflexible' through a hostile fleet, according to the tactics proposed by the French writers, would be infinitely more formidable if she were followed by an auxiliary ram on either quarter. The following opinions of naval officers are quoted in support of this proposition. Captain Colomb, in his paper on the attack and defence of fleets, read April 3, 1871, remarks:—'The ram pure and simple is strongly advocated as a weapon by Sir George Sartorius, and I must own that it seems to me a gunless ram of equal speed with the "Monarch," but about one-fifth her size, would meet her on equal terms in the open sea.' Auxiliary vessels should be designed to use one weapon only. Captain Colomb, R.N.

The views entertained by Sir George Sartorius were fully developed in a pamphlet, from which the following passages have been extracted:—'My reason for refusing guns to the unarmoured ram is that there should be no possible cause or temptation to distract the attention of the commander from the ram power. It was the guns and smoke from the Austrian rams that made them lose their best chance, when they ran between the Italian ships instead of into them, when the latter were firing their broadsides. I gain what is of more importance to these vessels in compensation for the gun—more speed and handiness. . . . The ordinary speed of the ram should not be less than fifteen knots, capable of rising to nineteen or twenty knots. . . . Two or three towers are necessary for musketry, grape-shotproof. These would be the stations for the captain and helmsman in action. Rams. Sir G. Sartorius.

'There is nothing in the form required for the ram which precludes an able constructor from keeping in view the facility of converting these vessels, when not required for the more formidable duties of their name, into most efficient sailing or steaming frigates and corvettes. For making passages they could have topmasts and topgallant-masts. A very little practice would soon render easy the lowering and raising of masts.'

Captain Colomb, R.N. 'Journal,' U.S.I., 1871.

Returning to the paper to which we have already referred, Captain Colomb expressed an opinion that the ram, if provided with an end-on fire, should in no case use her gun in approaching to ram an enemy, but that he should be glad to see his adversary use his guns, because his own movements would be disguised thereby. This opinion is confirmed by Admiral de la Gravière, who says:—'The poor advantage to be gained by a discharge, rendered uncertain by the rapidity with which the distance varies, cannot compensate for the cloud of smoke which will envelope the ship at an all-important moment. To a certain extent, manœuvring qualities are more important than high speed.'

Sir George Sartorius took part in the discussion on Captain Colomb's paper. He pointed out that if a ram were to attack a fleet at night, artillery fire would be useless as a defence. The rams he proposed were without guns, but were to be superior in speed to the vessels destined for attack. By giving up the armament, a large additional quantity of fuel could be carried, much more fuel, in fact, than could be carried by the vessels of the enemy's squadron. With this advantage of coal-carrying capacity on their side, they could, in the course of a very few days, compel the armoured and armed squadron to retire into port, in order to avoid being lost for want of steam.

Sir Edward Inglefield.

The following observations from a paper on 'Naval Tactics,' read by Admiral Sir Edward A. Inglefield, before the Royal United Service Institution on June 29, 1868, illustrate the important part which may be taken by auxiliary vessels acting in concert with first-class ships:—'It would be very difficult for two squadrons, coming at the rate of ten knots, to ram each other, very difficult for them to strike each other exactly. The rams should be brigaded together, to act when the enemy was paralysed, either by some disaster, or by "the first shock of battle," and it is then I believe the rams will be more useful than if they were to be the leaders of the fleet. At the commencement of the action, every ship being in her best trim, having her full power, and able to steer perfectly, it will be very easy to my mind to avoid the blow of any ram that is clearly directed

towards your ship. But, on the other hand, when a ship has been disabled or paralysed by a broadside, or by something which has happened on board of her with the first collision, it is then that I think the ram, not having been engaged, may run steadily into another vessel, because she has all the chances on her side, while the other is comparatively helpless.'

In the subsequent discussion the chairman, Sir Henry J. Codrington, said:—'There was another point mentioned about "ramming." I do not quite agree with Captain Inglefield, about putting the rams so far astern. I have not the least doubt that there will be very great difficulty of ramming in the first line. But supposing an admiral puts his ships in two efficient ramming lines, I believe the second line will be the one that will ram. The first attempts that will be made will result in confusion and *mêlée* between the two first ships that grapple; and it is those that come up immediately afterwards that will be able to act upon those which are still unscathed, but have lost their way; that is the time for ramming.' Sir Henry Codrington.

We have a similar opinion from Admiral Hobart in his recent article in the *North American Review*. The rams, he thinks, should lie by until one of the enemy's ships is in difficulty, and then rush at the injured ship with their ram. Admiral Hobart.

The writer of an article published in *Blackwood* in February, 1878, on 'Ironclads and Torpedoes' is equally strong in his advocacy of auxiliary vessels. *Blackwood*, February, 1878.

'The most useful auxiliaries which a squadron of ironclads could probably have, would be short, handy, mastless torpedo-rams, as recommended by Sir George Sartorius. These vessels should be protected by armour as far as possible, but they should carry no guns, and should be specially equipped for torpedo work of every description. Such a vessel would require but a small crew, and these would be all skilled torpedo-men. She would be of low freeboard, and would present a comparatively small target to the enemy; and effectual means would of course be adopted to protect the crew from small-arm fire. In a vessel of this type torpedo warfare could be carried out to the best advantage. Each large ironclad might have a torpedo ram attached to her as a tender, which she would take in tow when necessary, for the purpose of saving her fuel. In action, the duty of this tender would be to second the operations of her principal by ram and torpedo as opportunity presented. A few such vessels stationed at the mouth of the Thames, and at Ramsgate and Dover, would probably be of great service in war time.'

If the ram is to be regarded essentially as an auxiliary, the

As to the type of ram required.

displacement would probably be limited to an amount not exceeding 2,500 tons. In a ram of such dimensions every consideration should be subordinate to the use of the one primary weapon; but it does not follow that the ram should be absolutely gunless. The ram may be the more formidable weapon, but in the present state of naval warfare the gun cannot be abandoned.

Mr. Scott Russell on the use of the ram in action.

In his lecture at the United Service Institution on June 8, 1877, on the 'Development of our Modern War Fleet,' Mr. Scott Russell gave the following graphic description of the probable course of a modern naval engagement:—

'According to all the information I have gathered from the ablest men, the following series of facts are to be dealt with:—

'THE FIGHT BEGINS.

'Standing on the deck, 24 feet above the water, I see my enemy clear on the horizon. He is seeking me. I am seeking him. We are six miles apart; at modest speed a mile takes six minutes; at that speed we shall meet in eighteen minutes.

'What to do in these eighteen minutes is a serious question.

'There is not a heavy sea on, but an ordinary swell, our ships roll gently; steam steadily; our guns are charged; all is ready.

'Now comes the serious question—As we approach shall we fire or not?

'TWELVE MINUTES.

'Six minutes have passed, and we are now within four miles of each other, shall we throw away our shot?

'SIX MINUTES.

'Six minutes more have passed, we are within 4,000 yards of each other, shall we throw away our shot?

'Better reserve all for near and sure fire.

'THREE MINUTES.

'We are now end-on. 2,000 yards apart. Three minutes of time left.

'Shall we continue end-on?

'Shall we change our course?

'Why change our course?

'I dare not change my course!

'That is the answer to me by an able and experienced commander.

'Now I quite agree with our brave seaman that he dare not

change his course. It would be weakness. It would be fear. It might be folly.

'His orders must be, Stand by! Steady! Full speed ahead.

'THREE MINUTES APART.

'The three minutes are soon over! The engineer gets all in order for the crash! All in the ship is already made fast! The commander's eye never leaves the enemy. At the end of a minute, he sees the enemy hesitate.

'He swerves to port! Port the helm is our order. The ship swerves to port, but is too slow to escape us.

'The two minutes are over, he has not been able to get round more than four points. We also have got four points round, we are now full speed right athwart his beam.

'Stem on. Stem into him. His side is open to the sea.'

Commenting as a naval architect on the imaginary battle which he had described, he arrives at the conclusion 'that the first fighting element I have to meet is "greatest strength to strike my enemy with most harm to him and least to me," that the second fighting element is "greatest gun power"—to throw the greatest number of largest shells into him with highest speed at close distance and in shortest time. These two are, it seems, the first fighting elements which the modern man-of-war must possess.'

The ram and torpedo skilfully handled can produce terrible destruction; but the near approach of the two combatants which is necessary makes the effect of the recoil or the explosion not less perilous for the assailant than the assailed. For some time to come it may be assumed that the arms which strike a blow at a distance, such as the gun, will combine, all things considered, the greatest number of advantages in their favour.

Sir Edmund Commerell, in a speech at the United Service Institution, while recognising the superior efficiency for ramming of short, handy vessels, as against long and less manageable ships, objected to the building of any vessels not armed with guns. His experience of all exceptional vessels was that they were sure to be in the wrong place at the right time. The addition of a gun or guns, even though not protected, is essential to the general utility of a vessel of war. It would seem desirable, therefore, that provision should be made for a moderate weight of armament in any repetitions which may be proposed of the 'Polyphemus' type.

Sir Edmund Commerell.

In order to penetrate the hull of an enemy a ram must be able

... concentrated fire of all the guns of the ship against ... For this purpose the ... must be protected ... otherwise rendered ...

... necessary to add further evidence of the complete ... which prevails among naval officers and naval ... the value of auxiliary rams. They should be ... should carry a light armament, and have a speed of ... Their coal endurance will be very limited, but ... by the first-class battle-ships to which they are ... long passages are undertaken.

... to the battle-ships, sea-going torpedo vessels would ... formidable than rams. In dark nights, in fog or hazy ... the smoke and confusion of a naval engagement, it ... difficult to resist the attack of a swarm of such puny ... No less than one hundred and ten torpedo boats have ... built for the Russian navy, and if our squadron lately ... Eastern waters had been engaged in active hostilities ... would have been attacked by these small but terrible

... large expenditure has been incurred in providing an ... launching torpedoes from the first-class ironclads. The ... are becoming a more and more important feature in ... of an armoured ship. The value of this costly appa... conclusively established. Our naval resources would ... applied to greater advantage in the construction of sea... boats in increased numbers.

... can be protected by 2-inch armour in the form of ... which would be proof against grape or Gatling bullets. ... to protect the machinery and crew would not ... twenty tons. The light torpedo boats have an ... in the circumstance that, when driven at high ... before them a cushion of water, which prevents ... near the water-line, even in the event of the hull ... with rifle bullets.

... torpedo boats, capable of accompanying a fleet of large ... own steam or in tow, would be most effective ... Several sea-going torpedo boats of the larger ... built for the Swedish navy.

... Mr. Ericsson has produced a torpedo boat called the ... capable of steaming fifteen knots, which he undertakes ... cost of 10,000*l*. In a letter addressed to the *Army*

and Navy Gazette of New York, he says:—'Comparing the stated amount with that expended on the "Inflexible," it will be found that a fleet of sixty "Destroyers" could be built for the amount paid by the British Government for its stately monitor. It would, of course, be absurd to propound the question, Could the "Inflexible" resist an attack from the supposed fleet? But it will not be absurd to question whether the great ironclad could, unassisted, brave an attack from a single craft of the "Destroyer" type, capable as it is of defying heavy ordnance, and capable of approaching within any desirable distance before dispatching the torpedo.'

Torpedo boats of the 'Lightning' type can be produced at a cost of 5,500*l.* each; fifty, therefore, could be built for 275,000*l.*, or not more than one-third the cost of the 'Inflexible.'

Lieutenant Campbell, R.N.

Lieutenant Campbell, the writer of a recent Naval Prize Essay, recommends that every fighting ship should be fitted with two fast steam torpedo quarter-boats. Thus in a fleet of eighteen ships there would be thirty-six small torpedo steamers, dealing destruction on all wounded vessels of the enemy. In addition, Lieutenant Campbell recommends that every fighting ship should have a torpedo tender of from 200 to 400 tons, which should keep close to the line-of-battle ships, ready to dart out, and cause the enemy to give a sheer, or run her down and entangle herself, ready for the next line-of-battle ship to ram, or the next tender to follow up the attack.

The number of sea-going torpedo vessels, which should be attached to the fleet, cannot be determined by any definite rule. In the absence of experience the shipbuilding programme for an armoured navy must be more or less of a tentative, uncertain, and arbitrary character. All large ironclads being now supplied with torpedo boats, the sea-going torpedo vessels here proposed should not perhaps exceed the proportion of two for every first-class battleship. Their sphere of operations would probably be limited to European waters; and they would be towed whenever a sea passage was undertaken.

Vessels for coast service.

The same principle of specialisation must be followed in the construction of those coast-service ships, which on many occasions would afford valuable aid to the large and deep-draughted ships. The Committee on Designs give conclusive reasons for establishing distinct types for the various and diversified operations in which the fleet may be required to engage:—'As a powerful armament, thick armour, speed, and light draught cannot be combined in one ship, although all are needed for the defence of the country; there is no

[illegible] give the preponderance to each in its turn amongst [illegible] classes of ships, which shall mutually supplement each [illegible] therefore recommend that one class of coast- [illegible] possess the limited armour of the "Cyclops," [illegible] greater speed as can be obtained without any material [illegible] draught of water by sacrificing one of the turrets [illegible] remaining portion of the breastwork. As the suggested [illegible] would render her more serviceable at sea, we should [illegible] addition of such a superstructure as may be requisite [illegible] perfectly seaworthy.'

[illegible] bombardments and coast warfare the 'Monitor' type is the [illegible]

[illegible] in reply to the Secretary of the United States Navy, [illegible] Dahlgren expressed his views as follows:—'The monitors [illegible] advantages over every other type in their lighter draught, [illegible] and direction of fire around the whole circle; they [illegible] battery into the least depth of water. With vessels [illegible] the monitor will overpower the broadside.' On the [illegible] Admiral Porter pointed out in his report of 1865, [illegible] very slow, and not at all calculated to silence heavy [illegible] require a rapid and continuous fire to drive men [illegible] Monitors are famous coadjutors in a fight, and put [illegible] which tell on casemates and bomb-proofs. [illegible] light draught and high evolutionary qualities, moni- [illegible] secure against an attack with the ram. Lieu- [illegible] in his lecture delivered at Cronstadt, remarked:— [illegible] à leur construction, sont garantis de l'éperon. [illegible] l'aisance avec laquelle les monitors évoluent, [illegible] la facilité qui en résulte pour eux d'éviter les [illegible] dans mon opinion, le droit de dire que les [illegible] type de navires les mieux garantis contre les [illegible]

[illegible] 1874 Admiral Porter commends the double- [illegible] with higher freeboard as quite able to live through [illegible] Returning to the same subject in 1876 he [illegible] examines the various systems of foreign navies, [illegible] that the United States started on the right [illegible] and should follow it up by building vessels [illegible] but of greater power for ocean warfare.' For ser- [illegible] and in harbours and rivers, the success of the [illegible] was conclusively established by the hard fighting and

ample experience acquired during the war. The model designed by the Americans was soon adopted by other navies on both sides of the Atlantic. The monitor type was specially designed for coast warfare, and not for cruising upon the broad waters of the ocean. Sir E. Reed, in his work, *Our Ironclad Ships*, refuses altogether to accept vessels of this type for ocean service. No monitor of the American type can be considered a satisfactory sea-going vessel. Without a high freeboard the quality of habitability cannot be secured. Both Commodore Rodgers and Admiral Porter are agreed that the American monitors were not adapted for service as cruisers. The invulnerability which was one of the great sources of superiority in the original monitors was due to their low freeboard. This advantage disappears with the high freeboard, which becomes a necessity in a ship intended to keep the seas, and not merely to make an occasional passage from port to port.

Reconstruction of 'Cyclops.'

The reconstruction so often recommended by the constructors of the breastwork of the 'Cyclops' class would be the least costly means of furnishing a few sea-keeping coast-service ships to the navy. To render these ships absolutely seaworthy it is necessary to build up the sides of the ships to the level of the upper deck of the present superstructure or breastwork. We want some vessels of dimensions not exceeding those of the 'Cyclops' for the defence of Gibraltar and other stations, where the smaller ironclads of foreign navies may be encountered.

Time required to build small vessels.

It may be urged that auxiliary vessels can be produced so quickly that it is unnecessary to build them in anticipation of the emergency of war. We shall do wrong if we reckon on the command of time, and postpone too long the task of providing anything which is admitted to be essential to the efficiency of the navy. The telegraph and the railway have accelerated political complications, and brought contending armies more promptly face to face. There has been no corresponding acceleration, but rather the contrary, in the rapid creation of first-class ships for the line of battle. Even the smaller vessels, when of complicated design, occupy some months in building.

Messrs. Laird Brothers.

The following letter from Messrs. Laird Brothers gives more precise information on the point under consideration :—

Birkenhead Iron Works, Birkenhead,
March 4, 1871.

'In reply to your note of the 23rd ult. on the subject of ironclad vessels of moderate draught adapted for coast defence, and the possibility of building them with such rapidity in the event of our being

threatened with a naval war as to render it unnecessary to expend the national resources upon the construction of such vessels in time of peace, we agree with you in thinking that, although a large fleet of wooden gunboats at the time of the Crimean War was turned out with great rapidity, the more complicated type of vessel involved in an ironclad would take a much longer time to get ready for service.

'With regard to the gunboats, we suppose that even with all the exertions that were made it could not be considered that much less than six months elapsed between the time of their being ordered and being ready for service.

'With regard to ironclad vessels of light draught and low free-board, fitted with revolving turrets for one or two heavy guns, protected by thick armour-plating, we think that it may give you a good idea of what has been done to enclose a printed extract stating shortly the number of vessels of this class that we have built for different Governments, together with their tonnage, power, and draught of water.

'Of these, the "Bahia" was built in the shortest time, viz., about eight months; the "Lima Barros," "Heiligerlee," and "Krokodil" in ten to twelve months; and the larger vessels, "Huascar," "Prins Hendrick," and "De Stier," in periods of from fourteen to eighteen months.

'It is true that in the case of these vessels no attempt was made to work overtime to the extent of doing the utmost amount of work in every twenty-four hours which human labour is capable of executing, but ordinary diligence was used in carrying out the work, and to do more than this for the long period occupied in building a vessel of war is most difficult to organise and can scarcely be depended upon.

'Again, we must take into consideration that these vessels were all designed and built some years ago when the thickness of armour was less, and when consequently it was more easily fitted than it is now; in fact, what was done in the case of these vessels can only be taken as a general guide, for every year such an advance is made in guns and armour as to alter many of the conditions both in design and construction. In making these observations we are not unmindful of the fact that the improvement in the appliances for doing the work advances more or less in proportion to the difficulties of the work to be done, hence the actual time required for building vessels of the most improved type might not differ much from that occupied in building the older class of vessels when this kind of work was less understood than it is now.

'You may be aware that the Government are actually building four vessels by contract, ordered in August last: the "Cyclops," the "Gorgon," the "Hecate," and the "Hydra," of 2,107 tons and 250 h.p., each fitted with two turrets with two guns in each, or four guns altogether; the hulls being protected with armour eight inches thick, and the turrets ten inches; draught of water about fifteen feet six inches. These vessels are building under very stringent conditions as to time for completion, but we believe that the interval will nevertheless fall but little short of fifteen to sixteen months.

'It would therefore appear from what we have stated that we could not place much reliance on extemporising a fleet of ironclad turret vessels after war was declared, and it does not appear in the present state of political matters that much time is allowed to elapse between the occurrence of the complications that may ultimately lead to war and the declaration which leads to action being taken.

'The number of vessels ordered at one time (if a large number) might affect the time for building, as rapid progress is dependent on the prompt supply of armour-plates and other materials, the production of which is limited.

'In any case, no exact estimate of time can be made until the general design is settled, fixing dimensions and style of armour and armament, although such vessels as we have alluded to as having been built in the ordinary course of business might perhaps be produced in an emergency in a somewhat shorter time than we have named by extra exertions at any extra cost.

'We remain,

'Yours truly,

'LAIRD BROS.'

In connection with the general question under discussion, allusion may be made to a subject which is equally important both as it affects the period occupied in building ships of war and the cost of building them. It is desired to insist on two essential points:— Simplification of designs.

I. The simplification as far as possible in the designs for the structure of our ships.

II. The growing expenditure on internal fittings.

In *La Guerre d'Escadre* M. Dislère objects to the growing expense in fitting modern fighting ships. Everywhere steam machinery is asked for to work the capstan, to hoist the ashes, to perform every laborious manual operation. As it is necessary to carry large crews to fight the ships, a large expenditure on labour-saving appliances seems scarcely justified.

With regard to the simplification of designs it will probably be

sufficient to throw out a general suggestion. The designs for our ships afford proof of such ability on the part of our constructors that we may venture to rely on the adoption wherever it is practicable of simpler and cheaper methods. Attention is directed to the subject here on the general ground that economy is a main element of naval strength. If our ships cost less we should build them in greater numbers.

neral iclu- ns. ip- lding foreign kyards.

In bringing these observations to a conclusion we may refer once more to the proceedings of foreign nations. The construction of armoured sea-going vessels has been practically abandoned by foreign Powers, with the two exceptions of France and Italy. Russia, which has recently made the greatest efforts to prepare for active naval operations, has constructed more than a hundred torpedo-boats, as being the most effective means of attacking large ocean-going iron-clads in narrow waters. Russia has also equipped a considerable number of swift and lightly armed steamers, for the purpose of cutting up the commerce of an enemy.

In seeking for some indications as to the direction which we should follow in our shipbuilding policy, our attention will be confined to France and Italy. It will be accepted as an axiom that, while we may be ourselves so impressed with the importance of a superiority of numbers, as to be ready to surrender an extra knot of speed in order to increase our strength numerically, and while we may be of opinion that an armament of many guns of powerful but not unwieldy calibre is likely to be more effective than an armament of monster guns, necessarily diminishing in number as the weight and calibre are increased, yet, on the other hand, we cannot allow any foreign Power to possess vessels which we cannot overhaul, or to carry guns to sea which may inflict a damaging blow, to which it is impossible for us to reply. We must have ships as swift as the fastest, and guns at least equal to the most powerful, which are to be found in the hands of any possible enemy. The Italians are preparing to take to sea four 100 ton guns in ships having a speed of sixteen knots. They have also furnished their navy with an armament of four more guns of the same calibre, which will be carried to sea in two ships of a speed of fourteen knots. We must be even with them in speed and armament, but the same armament may be more formidable and effective, if distributed in twice the number of ships having an equal or superior speed. The latter plan would involve the construction of a much larger tonnage, and require therefore a heavier outlay in proportion to the armament. On the other hand, an advantage

would be gained, in a gunnery point of view, in the greater distribution of artillery, and the more perfect concentration of fire. The increased facility for a concentrated attack on a part of the enemy's fleet would be an important tactical advantage. If the ram were resorted to, the strength of the fleet in that most deadly though unwieldy weapon would be doubled, and the ships would be more easily manœuvred.

The naval weapons are the gun, the ram, and the torpedo, and we must build distinct classes or types for the effective use of each arm. The large ship will be designed specially as the gun-carrying type, and will be armed, as it has been proposed, with one or two of the heaviest guns, combined with more numerous pieces of lighter calibre. Two auxiliary rams should attend upon each first-class battle-ship. They will be of the 'Polyphemus' type, simplified in certain minor but costly details, enlarged it may be, and made more habitable, and well armed with machine guns. The stem should be designed specially for ramming, without the complication of torpedo fittings. The tonnage will probably be 2,500 tons, the speed not less than seventeen knots. The auxiliary flotilla will be completed with sea-going torpedo boats, of which there should be two or four to each battle-ship. They should be capable of steaming twenty-two knots. The tonnage and the cost of such a battle-ship as it has been attempted to describe, with the attendant flotilla of rams and torpedo boats, would be approximately equal to that of the 'Inflexible.'

Argument and theory would seem to show that our expenditure on battle-ships would probably be applied most effectively if our displacements were limited to 8,000 tons. The practical necessities of the situation demand a larger tonnage. While ships of eleven, twelve, and thirteen thousand tons are being built for Italy and France, our own constructors, with all their skill and ingenuity, may find it impossible to produce a ship which would satisfy the country, always so susceptible on questions affecting our naval supremacy, with a displacement of less than 10,000 tons. In battle it is possible that the large ships now building abroad might fail to realise all the anticipations of their designers, but a certain moral effect is undoubtedly produced by the concentration of power in one imposing vessel.

Our constructors are disposed to place more reliance on horizontal armour and minute internal subdivision than on side armour for protection against the ever-increasing power of naval guns. The reduction in the weight of armour by the adoption of the new

system gives promise of a return to the dimensions of the earlier ironclads.

The armament of the first-class battle-ship should be a mixed armament, including one or more guns of the heaviest calibre mounted *en barbette* or in an enclosed turret. Lighter guns of the improved patterns lately introduced will form an essential part of the armament, and should be carried on the broadside.

The 'Dreadnought' is a most successful type of turret ship. Should it be thought desirable to substitute in the ships of the future a mixed armament for one consisting exclusively of very heavy guns the after-turret might be dispensed with, and a battery of 18-ton guns might be substituted, protected, as in the French ships, against machine guns with 2-inch steel plates. In the 'Dreadnought,' altered as proposed, the flying deck would be no longer necessary. The ship would be far more habitable at sea. The armament would be more effective against all unarmoured ships, and against the large unarmoured surface of protected ships. A considerable armament of light guns might be carried on the upper deck as a defence against torpedo boats. The flying deck of the present 'Dreadnought' is too contracted to receive a sufficient armament of machine guns.

Two iron lower masts fitted with armoured crows' nests would be required. The masts being necessary as part of the fighting equipment, a light auxiliary rig may be supplied with advantage in many ways. A moderate spread of canvas would afford opportunities for exercising the crew, and would be valuable in handling the ship in heavy weather.

The conclusions to be deduced from this examination of the opinions of many minds on the shipbuilding question are :—

(1) The main expenditure should be directed to the construction of sea-keeping, sea-going ironclads. As compared with the masted broadside type, the turret ship is incomparably more formidable, for action at close quarters, but it is defective in the number of guns and in the quality of habitability at sea. A combination, therefore, of the central battery, armed with mitrailleurs and light armour-piercing guns, and one or two turrets mounting two guns of the heaviest calibre, as proposed by the Controller, and now being carried out in the 'Collingwood,' would seem to embrace the main features of a first-class ironclad.

(2) We must have some means of attacking the fastest ships in any navy.

(3) The first-class ships must be supplemented for active war service by auxiliary vessels, each specially designed for the use of

some one of the various weapons of naval warfare. We shall require rams and torpedo vessels as auxiliaries in fleet actions at sea, while coast-service vessels of the monitor type are the most effective for the attack of fortresses.

(4) Our earlier ironclads, though obsolete for European service, will still be valuable in the squadrons maintained for the protection of commerce on distant stations.

The programme here put forward is not in strict accordance with theoretical considerations; but the policy of the Naval Department must be determined not alone or chiefly by theory, argument, and opinion. We must be governed to a great extent by the policy pursued by other Powers. It must be acknowledged that the construction of rams and torpedo vessels as auxiliaries to battle-ships, however strongly recommended, has not yet been undertaken by any maritime nation. Our theoretical programme must be modified accordingly, the auxiliary vessels which would be required for warlike operations being built in smaller numbers, until the emergency arises. Whenever a naval war takes place it will present special conditions, and create new requirements as to *matériel*, which it is impossible to anticipate, and for the production of which we possess unrivalled resources. The largest and costliest ships will be attacked, and probably with success, by a swarm of assailants, puny in dimensions but agile in movement, armed with deadly weapons, and manned by a handful of men of devoted courage, and ready to lay down their lives for the defence of their country.

In the meanwhile it is a wise policy to expend the resources at the disposal of the Admiralty mainly in the construction of the large ships, which cannot be improvised; while, on the other hand, the auxiliaries, which would give such powerful support to the heavy ironclads in the day of battle, should not be altogether excluded from a comprehensive programme of shipbuilding.

In the section devoted to the subject, numerous examples have been quoted of successful designs for vessels of moderate dimensions. In Eastern waters, the Turkish navy possesses seven or eight vessels of from 2,000 to 2,700 tons displacement, well protected against medium guns, and powerfully armed in proportion to their displacement. In the limited navy under the Greek flag we find in the 'King Georgios' an admirable design of the kind indicated. The 'Vasco de Gama,' a very similar vessel, has been added quite recently to the Portuguese navy. Mr. Samuda has lately completed a small but highly effective ironclad for the Argentine Republic. With additional speed and other improvements such a vessel would be a useful addition to our own service.

As a last word on the subject, I venture to express an individual opinion that the protection of our commerce at sea should be the primary aim of our shipbuilding policy. Foreign officers and constructors are agreed that they cannot engage in the line of battle against England with the hope of success. They point to our commerce as the vulnerable spot—the heel of Achilles. These ideas are being carried out in practice. We see in foreign navies a recent and rapid development of a formidable class of cruisers, lightly armed, but of great speed and coal endurance. Vessels of this class are plainly intended not so much to fight an action, as to intercept and destroy the defenceless yet valuable ships of the mercantile marine of an enemy. We must be prepared to protect ourselves against the form of attack which we have most reason to apprehend, and the nature of which seems to be foreshadowed not obscurely in the shipbuilding operations of our maritime rivals.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION I.

DIMENSIONS.

SECTION I.—*DIMENSIONS.*

BRITISH NAVAL OFFICERS.

Admiral Rous.

Admiral Rous.

Letter to the *Times.*

I NOW approach a serious national subject—the enormous expenditure in building ships of war, most of which are failures.

We have been constructing ironclads of 9,000 tons at the cost of half a million, difficult to handle under canvas, sluggish in answering their helm; unwieldy giants, warranted impregnable because they may be hammered into toothpicks by the newly invented guns, and invulnerable when a 2,000-ton ship, designed by Mr. P. Drake, would by superior speed and quickness to answer its helm, give her five feet of iron ram and drill a hole twelve feet under her line of immersion. . . .

My theory is that no ship of war should exceed 4,500 tons, which can carry guns to penetrate any armour a sea-going ship can carry. I am a great advocate for Mr. J. P. Drake's models of ships, carrying rams, from which no ship could escape. Shots may miss, a ram with a good man at the helm never misses.

Admiral the Earl of Lauderdale.

Admiral the Earl of Lauderdale.

United Service Institution, March 1873. Observations on Mr. Barnaby's paper on 'Hotspur' 'Glatton' experiment.

Then, with regard to protecting the guns. I think it has been advocated that you had better have a good number of guns. Well, if you have a number of guns, it is quite impossible to protect them by armour. I have a great objection to go back to the old system of a number of guns. What we ought to have is, few guns and heavy ones, and those few guns in turrets. What I believe to be about the most powerful vessel that could be constructed nowadays would be a ram, with one turret and two 35-ton guns.

Sir Hastings Yelverton.

For special service, or a long voyage where a quick and certain passage is the object, the 'Achilles' is far superior to any of our finest frigates; and from what I have seen of her in blowing weather, I have no hesitation in saying that she is a safe and good sea-boat.

Sir Hastings Yelverton.

Report on the experimental cruise of the Channel Squadron, 1866.

We must not, however, lose sight of the fact, that, with all her good qualities, the 'Achilles' is, from her great length, most difficult to handle; and this defect in action, more especially if engaged with a turret-ship, might be her ruin.

It is, perhaps, going beyond the bounds of what is probable, but I feel certain that this ship might, and probably would, have to go out of action to turn round, thus exposing herself, in almost a defenceless position, to the fire of more than one of the enemy's ships. In the full-speed trial of steam she beat the whole squadron considerably. . . .

I have endeavoured, in this report, conscientiously and impartially to place before their Lordships the merits and failings of each ship, as vessels of war, as sailing ships, and as steamers; and as the result of this cruise, I feel bound to award the first place to the 'Achilles.' I am, however, of opinion that her great length is an insurmountable objection, and have no hesitation in saying that ships of the 'Bellerophon' class, from their size and general handiness, particularly under steam, will prove more efficient and serviceable for war purposes.

Turning power of ships.

The power of turning when at full speed on the measured mile, as shown by the table below, places the ships in the following order:—

Name of ship	Time of going round the circle	Diameter of circle in yards	Date	Remarks
	M. S.			
Bellerophon . .	4 10	559	August 17, 1866	
Pallas . .	4 24	573	April 18, 1866	
Ocean . .	4 57	480	June 25, 1864	
Caledonia . .	5 15	587	June 7, 1865	
Lord Clyde . .	5 19	502	February 10, 1866	Stores incomplete
Hector . .	5 36	—	February 23, 1864	
Achilles . .	7 15	916	March 15, 1865	

Captain Vansittart, R.N.

Captain Vansittart, R.N.

Parliamentary paper. Trials of Channel Fleet in 1868.

I submit that the 'Bellerophon,' owing to her moderate length, extraordinary facility of turning under steam, and heavy battery, and seeing that her steadiness of platform (as no doubt the rolling returns will show) is as nearly as may be equal to that of either the 'Minotaur' or 'Achilles,' must be pronounced the most formidable vessel of the squadron.

Captain Armytage, R.N.

Captain Armytage, R.N.

It is not surprising that even seamen should be impressed and led away (as it were) by the noble appearance and performances of the 'Achilles' when under sail, and lose sight of her defects as a fighting ship.

Trials of Channel Fleet.

Vessels of her class would undoubtedly, from their speed and stability, take a very important part in any future war, especially for chasing purposes, and for forcing an engagement with a retreating enemy; but once fairly engaged in '*close action*' and enveloped in smoke, they would, from their length, become an easy prey to short, handy ships, when the stem would most assuredly be freely used, and prove a formidable weapon of offence; more so even than the powerful guns of the present day.

Taking this view of the question, I have come to the conclusion that an efficient fleet should consist principally of ships under 300 feet in length, and not larger than the 'Bellerophon.'

From all that I have seen of that effective ship, and knowing her defensive power, no doubt exists in my mind (after allowing for certain minor deficiencies) that she is the most perfect specimen of an ironclad that has hitherto been in commission.

Sir Spencer Robinson.

Sir Spencer Robinson.

Evidence before Committee on Designs.

A total change in naval warfare is impending. What we want most is neither 'Sultans' nor 'Devastations,' but a class of immensely powerful torpedo ships, to discharge torpedoes under water, ugly, horrid, uncomfortable, miserable things to live in, absolutely good only in the day of battle, but on that day supreme over all they meet. Torpedoes are destined to a great position in naval war.

Admirals Elliot and Ryder.

The most destructive means of attack will be found in the ram and torpedo. The most efficient ram will prove the most efficient fighting ship, and the leading features, unsinkableness and handiness; which will constitute the best ram will also facilitate the avoidance of the enemy's torpedo. Looking to the growing importance of ramming and torpedo warfare, it appears most desirable to avoid building ships of such large dimensions as the modified 'Fury,' whose displacement will be over 10,000 tons.

Admirals Elliot and Ryder.

Dissentient report. Committee on Designs.

Captain Nicholson, R.N.

. . . I cannot see why speed should hinge on the question of size. . . . We could have vessels of 2,000 tons, of great speed. . . . I firmly believe that no ship should be built of more than 3,000 tons, even for armour-clad vessels of the line of battle.

Captain Nicholson, R.N.

Captain Nicholson. R.N., Naval Attaché for Europe. Extract from letter to compiler.

Admiral Hobart.

England requires large cruisers, vessels wherewith to defend her colonies. Should they be ironclads, heavily plated, or fast wooden vessels heavily armed, with compartments so well fitted that, if one or two should fill with water through being pierced by a shot, the vessel would not sink?

Admiral Hobart.

The *North American Review* 'On Naval Warfare.'

Admiral Farragut, who was one of the most intelligent naval officers of my acquaintance, with whom I had many conversations on this question, was of opinion that the latter class of vessel is the best.

Admitting that ironclad vessels are an absolute necessity, we come to the question, 'What kind of ironclad is best adapted for modern warfare?'

In such a case I think the first point to be arrived at is speed; the second, handiness in manœuvring; the third, sea-going qualities; and the fourth, that the vessel should show as small a mark as possible to the enemy's heavy guns, to his torpedoes, and to his rams. In attacking forts (a thing I think out of date, unless by way of making a diversion in conjunction with land-forces), all these points, excepting perhaps the third, are very important. As regards the first necessary qualification, many competent men say you cannot get speed with small short ships. In this, with the greatest respect, I must venture to differ. I think it is only a question of horse-

Admiral Hobart.

power and the shape of the vessel *under water*. Some of the small Turkish monitors, I found, kept speed better than the large frigates. Secondly, as to handiness in manœuvring, every sailor knows how much easier a short vessel manœuvres than a long one, and, in these days when ships carry enormous armaments, and guns of the heaviest calibre, a small vessel would, to use a somewhat vulgar expression, hop round the long craft like a 'cooper round a cask,' firing on her ponderous adversary from positions where her (the larger vessel's) guns would not bear, poking her with her rams, and in fact worrying her life out. For example, suppose that two or three small monitors attack a frigate four times their own size, they would, if not capture, give her what is called in America a bad time of it. Thirdly, sea-going qualities. I have had some experience in monitors, such as were supplied to the Turkish Navy by English builders, vessels with high freeboards, carrying four 18-ton guns in fixed batteries, which guns could fire in a line with the keel. Several such vessels I had with me in very heavy weather in the Black Sea for fourteen months, and I found they made as good weather as, if not better than, the heavier frigates, and that in point of speed they were even superior to them. In regard to the fourth qualification—namely, that vessels should show as small a mark as possible to the enemy. There can be no question as to the smaller vessels having this advantage, not only as regards gunnery, but in relation to torpedo attacks, with which newly invented war-weapons it would be much easier to strike a large object than a small one. Of course, in making these remarks it is difficult to employ, in relation to England, with her huge fleets, an argument that will apply to states with smaller navies. . . .

I fear that we cannot quite give up iron yet, though I admit that it is just possible we may be obliged to make some radical change in ironclad sea-going ships. Already the English Government, and the English naval men, are fully aware that some, nay, nearly all, of their broadside ironclads are practically useless—in the first place, because many of them, having been built years ago, are too lightly armoured and armed to compete with the huge ships now building and built, and that thus they are, though ironclads, of very little use, and the British public are pinning their faith on vessels of the 'Inflexible' and 'Thunderer' class, that are indeed vessels to make an enemy tremble to look on. They have the great advantage of having their decks protected from shot. They have not the huge masts and rigging, one morsel of which getting foul of the screw the vessel is at the mercy of her enemy, be that enemy ever so small a vessel. They are armed with guns that it would

have seemed almost a fable to talk about a very few years ago. They have enormous speed, and they carry coal for about twenty days' full speed. Still, the cost is fearful. The English Government, as well as other Governments, are beginning to open their eyes to the fact that small, heavily-armed ironclads will be *the* ships of the future.

Admiral Hobart.

Such vessels have all the attributes I mentioned as necessary—namely, speed, heavy guns, sea-going qualities, and powers of manœuvring quickly. Last, but not least, they are economical. . . .

I am, like many others, much puzzled to say what will be the effect of the torpedo in the next naval war. I think that, with a very good look-out, with electric lights so arranged that the whole (not a portion, that is most dangerous) of the horizon is made clear as day (and it is probable that, with some alterations in the present system of light, this may be arrived at), a torpedo attack, or rather a successful one against ships lying at anchor, may be prevented. Nets round the ships will doubtless be most efficacious also. I again speak of vessels at anchor. But your reader will ask, How about vessels under way? On this point I venture to think that a blockading squadron may be dreadfully harassed by large numbers of torpedo vessels, choosing their own time and weather, making dashes out of the blockaded port.

Then, again, how about torpedoes in a naval engagement?

It has been said that torpedo-boats with spar-torpedoes could be lowered during an engagement, and sent against an enemy. This seems to be a feasible plan, but I cannot help thinking that the spar-torpedo projecting from the side of the ship, as in the American men-of-war, would be still better.

Commander Noel.

Commander Noel.

On the best types of war-vessels for the British Navy. Prize essay, 1876, United Service Institution.

The *first class*, as represented in *Blackwood*, consisted of the 'Hercules' and 'Sultan.' To these will be added, as they are completed, the 'Alexandra,' 'Téméraire,' 'Nelson,' and 'Northampton.' Undoubtedly these are the most formidable ships of the line now in existence. The 'Hercules' and 'Sultan' have been thoroughly tested and are found efficient as sea-going ships. They combine fairly protected water-line and battery, heavy guns delivering their fire in all directions, with great speed and handiness, which carries with it a most terrible power of ramming.

The drawback to this class of vessels is their enormous cost; and when we consider that the explosion of one skilfully directed torpedo

Commander Noel.

would sink the largest of them, and that the thickness of their water-line armour is insufficient to resist a 9-inch chilled shell (thereby exposing their most vital parts to danger), we cannot bring ourselves to believe that the expenditure of over half a million sterling for each vessel has brought its adequate return. . . .

It does not become a nation rolling in wealth to quibble over the sum to be expended on the protection of that wealth. But in this, as in all other outlays, the country looks to receive the value of its money.

. . . .

The cost of our present sea-going ironclads is so vast, that of necessity it greatly limits their number. By a reduction in their size and in the complications of their build, we should soon find ourselves possessed of a considerably larger number of really efficient ships for the same sum now expended on a few monsters!

. . . .

At present, if one of our most expensive ships is promiscuously sent to the bottom by a ram (friendly or otherwise), or by one explosion of a well-directed torpedo, the country loses a large fraction of its naval strength, amounting perhaps to $\frac{1}{16}$. Reducing that expense would admit of an increase in the number, and consequently render the loss of one ship comparatively trifling.

. . . .

While completing this essay, a catastrophe occurred, which has caused a great controversy on our subject, and has given rise to many opinions as to the necessity for a change in the construction of our ironclads: I allude to the sinking of Her Majesty's ship 'Vanguard' by the ram of her sister ship the 'Iron Duke.'

This accident, while proving the awful power of the ram, strengthens my arguments in this essay, and points to the inexpediency of building such costly vessels, so wanting in floating power as to sink when casually wounded.

On Great Britain's maritime power, 1878.

I would suggest two classes of line-of-battle ships, the *first class* to consist of about ten vessels of 7,500 tons, with armoured conning-towers; these ships would be used as leaders of divisions, sub-divisions, or groups. The *second class* to consist of about twenty vessels of 5,000 tons, ordinary ships of the line. I have named fourteen knots as the full speed, because I consider a reserve of four knots necessary for a fleet of heavy ironclad rams when manœuvring at ten knots, and this is the highest speed that human power is capable of directing safely under such circumstances.

Lieutenant Eardley Wilmot, R.N.

One conclusion seems certain, that as with all concerns in this world, we can only approach perfection through a compromise, and that those matters which are deemed essential to the welfare of mankind are nothing more or less; so we must be satisfied with a ship that cannot be otherwise than a compromise.

Lieutenant Eardley Wilmot, R.N.

Essay on Great Britain's maritime power, 1878.

The point of disagreement is in what manner it shall be attained. We cannot combine, in a perfect manner, speed, turning power, heavy armament, complete armour protection, ability to keep the sea for a lengthened period—all, in fact, of those attributes which divided opinion has deemed necessary; and the question is, What shall be abandoned and what retained? Now, as regards a fighting ship, I consider the following points essential:—

1st. Speed.
2nd. Handiness in turning.
3rd. Heavy armament.
4th. Armour protection for guns and vital parts.
5th. Stowage for fuel.
6th. To offer a small mark for artillery fire.
7th. To be built in numerous compartments.
8th. Moderate in cost.

We will take each of these points in order.

First, as regards speed. It must be acknowledged by every one that this is an important quality for a fighting ship, as without a certain speed a vessel is practically helpless. I would consider fourteen knots the lowest rate, and with such a provision she could not find herself placed at a disadvantage, unless in comparison with some vessel in which speed had been the first and only desideratum.

Second, the turning power of ships I consider of equal importance. Possessing great handiness in movement will enable a ship to manœuvre with facility, will conduce to her safety in ordinary navigation, and enable her to utilise the ram or avoid such an attack with greater certainty of success. Thus it is impossible to overestimate the importance of this point, and to secure it we should be prepared to sacrifice in other directions. . . .

Last, but not least, comes the question of cost. Now it is evident that one ship will not make a fleet, however powerful she may be, and that, moreover, we cannot afford to spend a million upon a vessel

Lieutenant Eardley Wilmot, R.N.

that may be disabled by a single shot or torpedo. The estimated cost of engines and hull of the 'Inflexible' is stated to be 521,750*l.*; so that by the time she is finally completed and fully equipped for sea, it is reasonable to suppose that nearly a million will have been expended upon her! For that sum we should be able to produce two, if not three, vessels which will together form a more powerful force, carry more chances of self-preservation, and would inevitably, if pitted against the larger vessel, sink her.

Captain Colomb, R.N.

Captain Colomb. — Naval prize essay for 1878.

The most powerful single ship which can be produced for a given sum of money is not necessarily the most powerful naval force which the money can command. It is only so if the same money will produce nothing capable of matching her except a sister vessel. The question would arise whether two or more ships could not be built which—only costing a like sum—would be as much superior to her when combined, as she was to any former single ship.

Captain the Hon. E. R. Fremantle, R.N.

Captain the Hon. E. R. Fremantle, R.N. — Naval prize essay, 1880.

The proper function of a navy is but too often overlooked in modern days, when the proud title of Mistress of the Seas has been practically undisputed in our hands since the beginning of the century, but it cannot be too frequently repeated that the object of any real naval war must be maritime supremacy.

As La Gravière expresses it, 'A quoi peut servir une marine? Je réponds sans hésiter, à occuper les grandes voies maritimes!' To do this we require large vessels which can cruise and keep the sea, and of such ships our war fleet must mainly consist.

Mr. T. Brassey, M.P., who has given much attention to this subject, has pointed out the necessity for having ships of moderate size, and he objects to the Italian ships 'Lepanto' and 'Italia,' which are 14,000 tons, as too large, and praises the Admiralty policy of building ships of not much more than 9,000 tons.

We need not, however, pursue this subject further. Most people will agree that neither 'Lepantos' 'Dandolos,' nor 'Inflexibles,' still less 'Gammas' or 'Deltas,' are required for our ordinary fleet ship.

BRITISH NAVAL ARCHITECTS.

Sir William Fairbairn.

IN 1871, Sir William Fairbairn read a paper before the Institution of Naval Architects on the present and past construction of the navy. Referring to the large ironclads recently constructed, he said:—'No doubt vessels of this ponderous class, armed with large guns, would be formidable in action; but the question arises whether a smaller class of vessels, equally safe, and much more handy than the "Minotaur," the "Achilles," and the "Warrior," might not advantageously be introduced.' He was not adverse to a limited number of ships of 6,000 tons burden; but he apprehended that vessels such as the 'Bellerophon' would be nearly as effective. There was, however, another class of vessels, intermediate between the gunboat and the 'Bellerophon,' of from 2,000 to 3,000 tons burden, which, if well armed with large guns and powerful engines, would be fit for any service, either on the open sea, or in the estuaries of rivers, where it would be dangerous for larger ships to navigate. The total inaction of the French fleet during the Franco-Prussian war, and the possibility that ships of light draught might shortly be wanted in our own navy, induced him to urge the Government to give their attention to the subject.

Sir William Fairbairn — Institution of Naval Architects. Session 1871.

In 1864 he had addressed a letter to the Lords of the Admiralty, recommending the construction of strong, well-built, iron vessels varying from 3,500 to 4,000 tons burden, and carrying from four to six 350 or 400-pounder guns. He had proposed that such vessels should be protected, on the line of the neutral axis, by a belt of iron armour-plating.

Sir E. J. Reed, K.C.B.

In the debate at the Institution of Naval Architects, in 1868, on Admiral Halshead's plans for large turreted ships, Mr. Reed took a prominent part. He said:—'In all the opinions which I have been

Sir E. J. Reed, K.C.B.

Sir E. J. Reed, K.C.B.

Institution of Naval Architects. Session of 1868.

able to gather, after much anxious listening, from naval officers, I never found so uniform a concurrence upon any one point, as upon the point that these enormous vessels are undesirable. The defect, as I consider it, of extreme size runs through the whole of these designs.' Mr. Reed proceeded to explain that he had designed the 'Bellerophon' with a considerably reduced length in proportion to beam, notwithstanding that he had assumed that the engine power required would be much larger than for a short ship, the objects in view being to reduce to its smallest possible dimensions the surface to be protected by armour, and to produce a more handy vessel.

Sir Frederick Grey.

Sir Frederick Grey.

Institution of Naval Architects, 1868.

In the course of the same debate, Sir Frederick Grey expressed an anxious desire that we should be careful not to go too fast in building enormous ships, or we might find ourselves, ten years hence, with another set of obsolete vessels upon our hands, and have to begin all over again.

Mr. Barnaby, C.B.

Mr. Barnaby, C.B.

Institution of Naval Architects, 1868.

The discussion was continued by Mr. Barnaby, who said that it was a very grave question, and one which did not appear to be much thought of, how far we dared go in putting large sums of money into single ships, remembering that every ship in existence could be penetrated by the torpedo—the large ones as easily as the small ones. It seemed to him that, having obtained a ship which should be capable of steaming at a certain fixed definite speed, say of fourteen knots, and of carrying guns of the heaviest calibre, to go beyond that and to spend your money on very much larger vessels would be thought, in the course of the next five or six years, to have been the height of insanity.

Sir E. J. Reed, K.C.B.

Sir E. J. Reed, K.C.B.

From 'Our Ironclad Ships.'

The conviction of American officers with regard to ramming, after their experience in the war, may be fairly summed up in the words of Admiral Goldsborough:—'Every ironclad, as a matter of course, should be an unexceptionable ram; or, in other words, susceptible herself of being used as a projectile.'

The engagement at Lissa affords more conclusive evidence of the great results that may be achieved by the proper use of this method of attack, especially in actions between sea-going ships.

In order that a ship may be efficient as a ram, it is obvious, first of all, that she must be handy under steam. The effect of the blow she can deliver is in a large measure dependent on the directness of the attack, and an oblique or glancing blow on an enemy's side might sometimes do as much damage to the ram herself as to the ship she attacks. *Sir E. J. Reed, K.C.B.*

In his accompanying report, Admiral Ryder goes fully into the discussion of this point in his answer to the question—'What class, in your opinion, presents the greatest advantage for giving effect to ramming or otherwise?' He decidedly prefers the short class exemplified in the 'Bellerophon' to the long class of which the 'Warrior' and 'Minotaur' are examples, and in justifying this preference, says:—'The short class is the handiest, and is therefore more likely to hit the enemy if she is moving; to hit that part of her which it is desired to penetrate; to hit her at about the desired angle, so as to injure our own stem as little as possible; to minimise the wrenching strain on her stem, as this short class is more easily turned.' This able summary requires, I think, no further remarks in order to enforce its important bearing on the point now under discussion.

It may be interesting if, to these opinions of English naval officers, I add an extract from the report of the American Admiral Goldsborough. In speaking of the elements of efficiency in ironclads he says:—'Among these elements is that of celerity in turning, and as it is a point to which sufficient attention has not been given hitherto, I wish to impress my convictions in regard to it.' Then, applying this to rams, he adds, respecting their success:—'This, however, cannot be the case unless they can be directed with a great degree of promptness to any desired quarter, or turned with every degree of quickness necessary.' Farther on he says:—'But to return to the point of celerity in turning, no practical means, in my judgment, should be neglected, more particularly in an ironclad, to secure this cardinal quality.'

Taking, for example, a ship like the 'Rupert,' of about 5,000 tons weight, and supposing her to charge an enemy at a fair speed, say at ten knots per hour, the 'energy' of the blow she can strike is measured by about 22,300 foot-tons; and we know from the trials at Shoeburyness that the 600-lb. shot from a 25-ton gun is capable of penetrating all the French ironclads, for example, at a short range, although its 'energy,' when it leaves the muzzle of the gun, is only a little over 6,000 foot-tons. What then must be the effect of the 'Rupert's' attack? and what would be gained by doubling her size and making her of 10,000 tons displacement, like the 'Minotaur,'

Sir E. J. Reed, K.C.B.

even if the larger ship could be made to strike as fairly, which is, as a rule, out of the question? Admiral Ryder, in the report from which I have already quoted, says with respect to the long and short ironclads, represented by the 'Minotaur' and 'Warrior' on the one hand, and the 'Bellerophon' on the other:—'Speed and weight are, no doubt, of great importance in ramming, but both classes have speed enough and weight enough for the purpose.' The Admiralty and the French authorities have both acted on these considerations, in designing ships like the 'Hotspur' and the 'Taureau,' which are essentially steam-rams.

Letter to *Engineering.*

Sir,—The leading articles which appear from time to time in *Engineering* on naval questions—whether questions of the royal or of the mercantile marine—are written, if you will excuse me for saying so, with so much candour, fairness, and knowledge of the subject that I feel constrained to make some response to the appeal with which you conclude your article of Saturday last on the ironclad navy. When my last letter appeared in the *Times*, with the editorial comments upon it, I felt that some misunderstanding might arise from the inferences which the editor drew from my words, more especially as regards the presumed sufficiency of my proposals and the great stress laid upon my recommendation of vessels of less than 4,000 tons displacement. I should have at once sought to define my position with greater precision had I not already trespassed excessively upon the space of the *Times*, and, after all, such subjects are usually discussed with an amount of bias that makes it impossible to get nice distinctions, however important, clearly appreciated. Moreover, I feel a good deal of aversion—not unnaturally I presume—in supplementing more than is strictly necessary the statements which I offer as a member of Parliament to the House of Commons with newspaper explanations during the sitting of Parliament. There is no sufficient reason, however, for my withholding from you a few words which may serve to clear up difficulties which you evidently felt in penning last week's article.

Let me say, therefore, that in recommending the speedy construction of half a dozen vessels of comparatively small size, but nevertheless with great offensive and defensive powers, I offered a suggestion which seemed to me, and still seems, entirely appropriate to present circumstances; but I did not intend at all to imply that we were to abandon the construction of large ironclads, or to abandon either those supreme powers which only large ironclads can be

Sir E. J. Reed, K.C.B.

endowed with. I think you will see, even if you do not concur with, my reason for recommending the laying down of additional smaller vessels only just now, if you will recall to mind the fact that at the present time we have several large vessels under construction, two of which, the 'Ajax' and 'Agamemnon,' are practically only now being commenced. As regards large vessels, therefore, I think the speedy development of our strength in this class of vessels would, with a given expenditure, be best effected by concentrating our efforts upon the advancement of the 'Dreadnought,' the 'Thunderer' (which is still incomplete), the 'Téméraire,' the 'Inflexible,' the 'Ajax,' and the 'Agamemnon,' rather than by spreading our money over the early stages of two or three new vessels, which could not be expected to take their place in the Navy for at least four or five years. Added to this consideration I feel, and have long felt, that we are very deficient of a smaller class of ship which would be the most advantageous possible for our purposes on distant stations, and would at the same time carry guns of such power (although few in number per ship) and such armour as would fit them to act in the most valuable way as auxiliaries in a European war. I cannot concur with your view that 'if we build this batch of cruising ironclads, the heavy fighting ships will be starved for years to make up for them.'

Most assuredly the House of Commons would not sanction any reduction of the progress which the Government propose to make with the ships which I have named above, nor would the Government itself, I believe, suggest any such reduction. On the other hand I feel pretty sure that neither will the Government now propose, nor will the House of Commons collectively at present urge, the laying down of new large ships with so many already on the stocks, and, therefore, as I think, my proposal to build in two years six smaller vessels costing a million is the best, and probably the only proposal, by which we may possibly secure an additional present outlay upon ironclads, that outlay being drawn in part from new funds to be voted, and in part from the amount which is appropriated in the present *Estimates* to the building of unarmoured ships, some of which, as I said, the Admiralty might be able and willing to dispense with in view of six new ironclads of moderate size being substituted for them.

I will not add to these explanations, but I felt that I could not well withhold them from a professional paper which devotes so much time and trouble to the temperate and judicious discussion of naval engineering questions.

I am, Sir, yours obediently,

London, S.W.: April 3, 1876. E. J. REED.

Sir E. J. Reed, K.C.B.

Extract from a paper read at the Society of Arts on 'War-ships and Torpedoes,' April 1877.

Small ironclads of great breadth and short length can be made so handy as to find in their own agility—associated with such modifications of form as are necessary even for them—sufficient security against torpedo attack. But in the case of line-of-battle ships a total change of form is necessary to meet the torpedo, and the days are already numbered of war ships more or less long and narrow, and with deep bottoms of thin iron, containing the steam boilers and powder magazines. How that change is to be brought about in this country under our system of administration I do not know. But this I know—that it must be accomplished somehow, and that the proposal of the Government to lay down a ship of the 'Agamemnon' class at Chatham must be reconsidered. The design of the 'Agamemnon' was made two or three years ago, before the tremendous capabilities of the torpedo had been developed, and to repeat her now would, in my opinion, be to confess our inability to surmount the new difficulties of war ship design. I should like to speak of many other changes which must be made in the ships of war of the future. Some of them may be foreseen distinctly enough, and only want of time forbids me from forecasting a few of them for your information. But the torpedo question, which has already absorbed so much of our time, has yet another aspect which is of such immense importance to us as a nation that I cannot pass it over. I am quite aware that the public must be getting tired of this war ship question, and of its continual change and progress, and, to tell the truth, I expect to see it fall more or less out of the public mind and out of the public interest from sheer fatigue of pursuing its troublesome transformations. I am myself not a little tired of it, and yet I must endeavour to do my duty in it still. The serious fact in this torpedo matter is the cheapness and facility with which the new weapon can be turned against us. In former days, during all the ages from the invention of gunpowder down to the present day, increased offensive naval power has only been obtainable by increased size of gun, which has carried with it a thousand other increases of cost and of difficulty. Even of late, when the gun has grown to such gigantic proportions, although we at first sight shrink from its consequences, we soon steady ourselves with the recollection that such guns cost enormous sums of money themselves, that they can only be worked by means of steam and hydraulic appliances more costly still, that they can only be carried with speed at sea in steam ships of a yet far more costly character, that when the whole mighty engine—ship, gun, and all other appliances—is at length produced, they can only be made available by exercise and practice for the acquirement of skill by

means of still further outlay for fuel, for powder, and for shot and shell; and, in short, that the bringing of big guns against our big guns at sea in suitable ships is a game of lavish expenditure and extravagance which but very few, indeed, of the Powers even of Europe can afford to engage in upon a scale commensurate with our own. But the torpedo is a weapon of offence differing altogether from a gun in all these respects; for, although each torpedo itself costs from 400*l.* to 500*l.*, it can be discharged from almost any ship or boat whatever, and the fittings for discharging it are of an inexpensive nature. Here, then, we have every Power furnished with the means of attacking our large war ship so cheap and so simple that few Powers are too petty or too impecunious to provide them on an emergency, while the larger Powers could, with the financial means at their disposal, completely compass and surround our few largest and finest ships with these agents of destruction. In my opinion, this state of things imposes altogether new and solemn obligations upon our naval administrators, and the objects to which it points are clearly twofold—first, the construction of our large ships on principles which make them as little destructible by torpedoes as by guns, which I believe to be quite possible; and, secondly, the building of all our other war ships of small and handy types, and with the necessary improvements. With these objects neglected, we shall be placed in a position of serious disadvantage and danger; with these wisely and scientifically attended to, Britannia may in the coming days, as in the past, continue to rule the waves. *Sir E. J. Reed, K.C.B.*

Mr. Barnaby, C.B.

In 1873, Mr. Barnaby, in his paper on unmasted sea-going ships, spoke in confident terms of the superiority of the 'Devastation' or the 'Thunderer,' to the 'Minotaur,' the 'Monarch,' the 'Hercules,' or the 'Sultan.' Yet, he said, as a matter of first cost, these ships would not reach the cost of the 'Minotaur' by 140,000*l.*; nor that of the 'Monarch' by some 40,000*l.*; and they could be fought by half the number of men. *Mr. Barnaby, C.B.* — Institute of Naval Architects, Session 1873.

In his paper read in 1874, Mr. Barnaby again enlarged upon the advantage of reducing the cost of individual ironclads, and quoted the 'Shannon' as an illustration of the progress which had been made in this direction. He showed that that vessel would be much Institute of Naval Architects, Session 1874.

more formidable to powerful, fast, unarmoured ships, than such an adversary as the 'Minotaur,' which had twice her bulk, twice her power of engines, and which would cost twice as much money; while the armour of the 'Minotaur' had but little more than one-third of the resisting power of that of the 'Shannon.' If he were to compare the 'Shannon' with other ironclads, he should pit against her the latest completed, viz.: the 'Swiftsure' and the 'Triumph,' although the relative cost would stand at 65 for those ships, against 54 for the 'Shannon.'

He proceeded to show the numerous advantages which had been secured in the 'Inflexible' over the 'Devastation,' the 'Thunderer,' and the 'Fury,' the thickness of armour having been increased in the first-named vessel from 14 inches to 24 inches, the weight of the guns from 35 tons to 80 tons, their number from two guns ahead to four guns ahead, the height of ten feet for working the anchors having been raised to 20 feet, and a reduction of nearly three feet having been made in the draught of water. The ship was divided into 127 water-tight compartments. Mr. Barnaby stated that it was his belief that in the 'Inflexible' we had reached the extreme limit in thickness of armour for sea-going ships. The temptation was always great to secure more and more power by the expenditure of ever-increasing sums of money; but it was his conviction that we should not, in any future ship, go beyond the expenditure on the 'Inflexible.'

In the session of 1876, Mr. Barnaby, in his paper on ships of war, referred to an opinion expressed by him in January 1867, at the Institution of Civil Engineers. He had said on that occasion that it must be borne in mind that, however thick the armour might be, the bottom of the ship was left as weak and defenceless as ever. Torpedo boats, made proof against almost any fire that could be directed against them, could be carried in sea-going ships, and doubtless, would be so carried, and employed. In view of these new and undeveloped, but terrible agencies, it was desirable not to create a large fleet, like that recommended, at a cost of many millions sterling; which fleet, although rendered secure from the effects of gunpowder above water, might easily be rendered obsolete and useless, because undefended from the effects of gunpowder fired from beneath. The experience gained during an interval of nine years, had convinced Mr. Barnaby that the torpedo could be made, within the proper range of its operations, irresistible. The possibility of attack by armoured rams or torpedo-ships, or by numerous unarmoured vessels of that

kind, exposed the costly armour-clad ships to a risk which they ought never to encounter alone. The assailants ought to be brought to bay, before they could get within striking distance of the iron-clad, by consorts, armed, like the attacking vessels, with the ram and the torpedo, which must, like them, run the chance of being sunk. In other words, he contended that the defence against the ram and the torpedo must be sought for not in the construction of the ship alone, or mainly, but also, and chiefly, in the proper grouping of forces at the point of attack. *Mr. Barnaby, C.B.*

Each costly ironclad ought to be a division, defended against the torpedo and ram by small, numerous, but less important parts of the general force.

Sir Spencer Robinson.

In the debate which ensued, Sir Spencer Robinson said that no suggestion, more valuable for the purposes of war, had been made by any person, within his knowledge, than the able suggestion which had been made by Mr. Barnaby, that the true mode of defending our heavy ironclads from attack was by the counter-attack of torpedoes and rams. No fleet, therefore, could be considered a fleet, and, in his humble opinion, no ship like the 'Inflexible' could be considered a ship of war, till she had her attendant rams and torpedoes, to meet those attacks to which she was sure to be subjected. *Sir Spencer Robinson, K.C.B. I.N.A. 1876.*

Sir Edward J. Reed, K.C.B.

He was quite satisfied that it was by counter-attack, and not by piling mountains of iron on the sides of your ships, that you could defend them from torpedoes. Mr. Reed took part in the same debate, and expressed his concurrence in Mr. Barnaby's suggestion that the proper way to defend armoured ships from rams and torpedoes was by means of auxiliary vessels. He was led to this conclusion for the excellent reason that there seemed to be a concurrence of opinion setting in that direction. If, however, it were admitted to be a necessity that auxiliary vessels should be employed to defend our ironclads, Mr. Reed suggested that it must tend to limit or to do away with the use of ironclads themselves at sea. Such a proposal, in fact, practically involved the abandonment of the use of armour-plated ships at sea; for auxillary vessels could scarcely be expected to keep company with ironclads on an ocean cruise. The use of ironclads would therefore be limited to coast operations and confined waters. *Sir E. J. Reed, K.C.B. I.N.A. 1876.*

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[illegible] B[illegible], C.B.

[illegible] of defending a ship against [illegible] make the ships smaller and [illegible]

In all these cases I have paid attention especially to the cost of the ships, because this is daily becoming of more importance. In modern marine warfare there are three modes of attack which are of

a far more fatal character than any to which ships of war were formerly exposed, and a successful attack by either mode will probably lead to the foundering of the ship. The modes of attack to which I refer are, the 'submarine gun,' the 'torpedo,' and the 'ram.' And it is to be observed that the large and heavily-armoured ship is absolutely inferior to the smaller and weaker ship with regard to the attack of torpedoes and rams. The very hugeness and weight of the ships make them the easier prey to an enemy who attacks them below the armour.

Mr. Barnaby, C.B.

United Service Institution, January 24, 1872. Paper on 'Modern Ships of War.'

From the under side of the armour belt, *i.e.*, from six feet under water to the keel, the ship costing 500,000*l.* is as weak as the ship costing only 100,000*l.*; and she is more exposed to attack. So long as this is so, the most efficient ship is that which, on the smallest dimensions, will carry into action at a thirteen or fourteen-knot speed guns capable of penetrating all but the exceptional armour of the ships of foreign Powers, and protected by armour, proof to all but the exceptional guns of those Powers. It is in this aspect that the 'Vanguard' class commends itself to my judgment.

Responding to the toast of the Navy at the Mayor of Rochester's dinner, Mr. Barnaby referred to the recent statement in a London morning paper that a ship was being built in the adjacent dockyard of Chatham to cost a fabulous sum, be thought about a million. It so happened, he said, that while foreign Governments were actually spending at this moment nearly a million of money on single ships, the British Admiralty, when they came to consider what England could afford to do, came to the conclusion that we could not afford that sum, and they said that what they wanted was a ship as fast as, and which could do a great deal against, such vessels as those he had alluded to, but which would not cost nearly so much money. Chatham was called upon to build such a ship, and that was the ship in question, which would be finished for about 140,000*l.* or 150,000*l.* instead of a million. They might depend upon it nobody was more anxious than the people of London to keep down the cost of ships, for nobody was more conscious of the necessity of a number of ships to protect the wide-spread interests of a great nation like this. Since 1870 there had been launched fifteen ironclads, nearly eighty unarmoured ships of war for foreign service, thirty gunboats, and a large torpedo flotilla, and when it was necessary to build such numbers, they might see how important it was to keep down individual expenses.

Speech at Rochester, November 15, 1878.

Mr. Scott Russell.

Mr. Scott Russell

Institute of Naval Architects, March 19, 1875. Paper 'On the duties, qualities, and structure of the modern ship of war.'

Since 1865 we have profited by the experience of naval war in America and at Lissa, and have learned from them two great lessons: That fast unarmoured ships can protect or destroy the most valuable commerce of the ocean, by chasing and sinking merchant fleets; that a small ship, with one great gun, well protected by turret or shield, can destroy a fleet of the best bygone men-of-war, however large, however well manned, and however many her guns; that one strong fast ship, well protected and well commanded, and skilfully built, and skilfully manœuvred, can sink a ship and disperse a fleet, without firing a gun, by that new tactic, concisely called 'giving the stem,' or simply running down. . . . .

I will now, therefore, ask you to consider a war vessel from the opposite point of view. Let us ask ourselves what is the smallest vessel fit for modern warfare.

My personal opinion and experience have grown steadily towards the conviction that we should consider a modern war vessel as a mere tool or instrument of destruction, not a ship in the eyes of the sailor: quite unworthy of the name; a mere floating gun-carriage—a mere floating spear, propelled by steam, and meant, first, to place an explosive shell in the enemy; and, second, to run into his side and sink him. If I am right in supposing that what I say truly represents modern naval opinion, then we come to a very simple practical conclusion. Let us take one big gun, let us give it the largest bore, the largest shell, the highest penetrating speed we now know. Let the vessel herself be considered in the light merely of a floating gun-carriage. Let this one large gun occupy the chief place in the vessel in front of her engines and boilers and propellers. Let it be as small a ship as is consistent with high speed; let it be propelled by high engine power; let it show very little above water; and let it have a short ugly stem to strike the enemy and sink him.

Not only high speed, but admirable dexterity and quickness of movement or manœuvring are indispensable to this sort of vessel; she must be low in the water—nearly unsinkable—all her decks perfectly closed—waves must break over her without harm; she must be steady, quick, and sure.

It may be said that such a ship is hard to find, and hard to make, and hard to handle. Certainly she is hard to work; but is not all great noble work hard, and are not victories always hard to win?

Sir Spencer Robinson, K.C.B.

Sir Spencer Robinson, K.C.B.

Royal United Service Institution, June 8, 1877. Discussion on paper by Mr. Scott Russell.

A single ship, however perfect, let it be the 'Inflexible' or let it be the smallest gun-boat of the 'Alpha' class, any single ship cannot in any way whatever represent the necessities of this country in naval warfare, nor can it represent the weapon which a naval officer on general service will have to use in destroying those ships of the enemy it may be his duty to destroy, or in making those attacks upon an enemy's fleets, fortresses, or positions, which it may be his duty to make. The country wants ships which shall in their various ways perform those services of assault and defence through which a naval warfare must be carried on. . . . We should all agree in this, that a fleet is, in fact, what we want; that a fleet must be composed of ships of various classes; that no single ship alone will be adapted for naval warfare under the circumstances of the development of science, and the means of destruction that now exist, and that every ship must act in combination with other ships; she must be the unit round which other ships congregate, and when we have got the ship and her satellites in attendance upon her, of the right size, sort, and stamp, then we have got the one unit of force capable of doing its duty in what may be called single action. But I think if you cannot admit so much as that, you must at least admit this, you must say that the whole fleet of Great Britain must be so constructed that each unit of its force shall be composed of ships of various classes, attended by others, larger or smaller, as the case may be, and that the concentration of these ships and their attendant satellites will alone constitute a fleet calculated to destroy anything that may come upon the surface of the sea.

ENGLISH PRESS.

Times.

Times. September 11, 1876.

As the Chief Constructor of the Navy has stated that it is in the 'Nelson' and 'Northampton' that his ideal of a fighting ship is to be seen, we must presume that he has designed them to carry the heaviest artillery known to naval warfare. If they approach this aim at all nearly, they will be a most formidable addition to our fighting fleet, and it will represent a valuable improvement in naval construction if armour can be thus reduced with safety.

At the same time, if there is any room for common sense in judging of naval matters, it cannot but be a little perplexing to the public to know why the recommendation of some distinguished naval architects, including Mr. Reed, advising the construction of a greater number of smaller vessels, is not acted upon. The great danger of modern warfare at sea is that the sinking or disabling of a ship involves such a tremendous loss. These two vessels of Mr. Barnaby's, however good they may be, are probably liable to be utterly disabled by some chance shot from a very powerful gun. Granted that the chances are strongly in favour of their escaping that risk, still it can hardly be maintained that they are not liable to it; and if they are, the question immediately suggests itself to an ordinary man why their armament and their crew should not be dispersed. Is there, in short, any such advantage in a battery of half-a-dozen guns in a single ship over the same guns dispersed in six smaller ships as is sufficient to justify our incurring the risk of seeing the whole six go down together? The shot which would inflict on our fleet this disaster would, on the other supposition, only sink one gun, while the other five would be left free for action. The question would seem to come back to the cardinal condition from which we started —namely, that the one essential point in naval warfare is to be able to put afloat and keep afloat the largest number of the most powerful guns. Why should not these be, so to speak, mounted on separate

carriages, just like the guns of a battery of artillery on land? One would imagine that there might even be considerable advantages for manœuvring in such a dispersion of force, and that a large iron-clad surrounded by a swarm of vessels which, though comparatively small, carried guns as heavy as her own would be under some difficulty in encountering them. There may be reasons sufficient to condemn this suggestion; but none such have ever been clearly stated. The expense of such ironclads as the 'Nelson' and 'Northampton' is enormous, and the number of 'eggs' carried in such 'baskets' is frightful to contemplate. Even if some large ships should still be desirable, a considerable number of single-gun ships would, it would seem, be an invaluable addition to their force. There is some reason to apprehend that we are still entangled in the old tradition of broadside firing, and that there is need of some original initiative at the Admiralty. It is satisfactory, however, to know that our naval architects are not idle, and that we may rely on constant, even if somewhat slow, progression. *Times.*

Few Englishmen follow very closely the details of the prolonged and desultory war between the Chilian and Peruvian Republics. An important event, however, has occurred to break the monotony of petty engagements and wasteful and apparently purposeless blockades and bombardments, and to excite an interest in the struggle which it has never hitherto inspired. A naval battle has been fought, and the Chilian fleet would appear to have been completely successful. At all events, it is said to have captured the famous Peruvian turret ship, the 'Huascar.' It is a curious coincidence, which will not escape notice, that almost simultaneously with the return to Spithead of the 'Shah' comes the news of the capture of her old antagonist. The 'Huascar' is a historical vessel. She is famous not merely for her three hours' hot fight with the 'Shah' and the 'Amethyst,' she has been for seven months the sharpest thorn in the side of the Chilians. She has figured in all the naval engagements in the course of the war—and the war has been strictly maritime from first to last. She has bombarded the towns of the Chilians, chased and captured their transport vessels, entered harbours and destroyed boats and launches; for months she has been the terror of the Chilian coast. Commanded by a skilful and daring officer, and manned by an excellent crew, the 'Huascar' was always a formidable adversary to most vessels afloat, and we are curious to know to whose superior prowess she finally succumbed. October 10, 1879.

Times. In her fight two years ago with two English men-of-war, she showed that she was a most dangerous opponent. Her hull being only three feet out of the water, it was difficult for the gunners of the 'Shah' to hit her. Her draught of water was small, and she was enabled to go inshore to places to which our vessels could not follow her. She steamed swiftly, and could turn easily, and Admiral De Horsey's vessel ran considerable risk of being rammed by her agile enemy. The guns of the English frigate were of no avail against the cuirass of the 'Huascar,' and had the heavy shot of the latter struck our wooden ships, the result might have been calamitous. The fighting powers of the 'Huascar' were again tested in an engagement, disastrous in some respects to the Peruvians, which took place off Iquique. The Chilian vessel, the 'Esmeralda,' fought on that occasion with valour and skill; but she was rammed and sunk by the 'Huascar.' It was in this hard-fought battle that the 'Independencia,' one of the most powerful vessels belonging to the navy of Peru, was lost. This was a serious blow to that Republic. The only fact which could console the Peruvians was the prowess of the 'Huascar,' which showed how much one swift, skilfully-handled vessel can accomplish in any circumstances. Since that engagement the 'Huascar' has never ceased to harass her foes. It is only a short time since she made prize of a large Chilian transport, the 'Rimac.' If the Peruvians have been able to hold their own on the sea, if they have succeeded in revictualling and garrisoning their ports and fortifying places which were exposed to the attacks of the Chilians, it is in great degree owing to the exploits of the 'Huascar.' Obviously the conditions of the struggle, which must continue to be waged on sea, are seriously changed by the loss by the Peruvian navy of its two most powerful ships, and the transfer of one of them to the enemy. It is not impossible that for the time the naval power of Peru is completely crippled by this fresh disaster.

In this country the origin and progress of the war have not been watched with much care. Attention has been more directed to the serious and wanton loss of life and property which has occurred than to the merits of the dispute. Such deplorable events as the bombardment of Pisagua, attended by incalculable misery, and apparently exercising no effect on the result of the war, have made people forget the real interest of the struggle. It is unfortunate that two neighbouring States, which have within them so many elements of prosperity, cannot live at peace. It is a pity, also, that the war is conducted with so little regard to the rights of non-combatants and in a phlegmatic manner which retards the return of

peace. But in some respects the contest is unique, and it ought not to be ignored by students of naval warfare. It is fruitful in lessons as to the altered nature of naval engagements. There have hitherto been few opportunities of knowing what were the capabilities and defects of ironclads in action. We have had to walk mainly by the light of theory A few engagements in the course of the American war indicated that old rules and traditions no longer held good. The battle of Lissa corrected some errors, and sailors and naval engineers have no doubt profited by it. The running fight between the 'Huascar' and the 'Shah' was also rich in instruction. It showed, indeed, that wooden vessels skilfully and boldly handled were not wholly useless when opposed to an ironclad. But it brought to light still more clearly the immense risk run by a long vessel difficult to turn which has to fight a short turret-ship armed with a ram. Though creditable to our ships, the engagement made it perfectly clear that it was improper to intrust the guardianship of English interests in the Pacific to wooden vessels. This view was confirmed by the fate of the 'Esmeralda' in her fight with the 'Huascar.' Nothing could surpass the courage of her captain and crew. The behaviour of the former was worthy of that sea Viking, Lord Cochrane himself, who appears to have infused into the Chilian navy a spirit which it has never lost. But the skill and courage of those on board the wooden ship were of no avail against the powerful ironclad. Well-directed shot produced no effect on the iron-cased hull of the 'Huascar;' and after being repeatedly rammed the 'Esmeralda' sank. Still, wonderful though the exploits of the 'Huascar' have been, it is well known that vessels of her type have their defects, that they are liable in actual warfare to accidents which suddenly disable them, and that they sometimes prove as formidable to their own side as to the enemy. We know the good points of our new ships of war; the strength of their armour, the large calibre of their guns, and the formidable character of their rams are patent to the eye. It is their shortcomings about which we need light, and perhaps the engagement at Mejillones will elucidate the defects of our ironclads. It can hardly fail to furnish valuable suggestions and hints to this country, which reposes so much confidence in its ironclad fleet.

Times.

One lesson which appears to lie on the surface of the war, so far as it has proceeded, is important. The 'Huascar,' which has served the Peruvians so well, was no huge, lazy, slow-moving monster; it was no mere floating battery. It has been useful just because it has been swift and agile ; it would not have inflicted a tithe of the

Times. mischief on the Chilians which it has done if it had been cased in the heaviest armour and had not steamed fast. It has moved quickly to and fro along the coast, and has thereby virtually multiplied the naval strength of Peru. It has played the part of an 'Alabama,' being more than a match in speed for the Chilian transports and merchantmen. When it fought with wooden vessels its armour and heavy armament gave it an incalculable advantage; and if it had been pitted against a larger and slower ironclad, its speed and the ease with which it could turn and deliver a blow with the ram would have made it a dangerous opponent. In a large navy such as ours there is room and use for many kinds of vessels. No one model ought to exclude all other types. There must be variety commensurate with the diversity of duties which our ships of war must perform. But what is clear is that we ought to have plenty of vessels with the serviceable qualities of the 'Huascar' type. Though not a powerful vessel, as judged by the war ships of the first class in our navy, the 'Huascar' is one of those handy, useful ships which in the actual work of warfare do far more than vessels much more costly. They preserve the good points of a smart, swift frigate, while they have fighting qualities which no unarmoured ship can possess. They can capture a transport ship, serve as convoy to a merchant fleet, hasten to a distant station where they are needed, or sail in shallow water near to a land battery and silence it. It is highly probable that operations in future naval wars will largely fall to vessels of this useful type, of which the 'Huascar' is an example. If this type has proved useful to Peru, it is likely to be still more advantageous to England, whose men-of-war must be fitted to go everywhere and do anything.

Broad Arrow.

Broad Arrow.

July 1876.

Rapid increase in the cost of ironclads.

A Return, which has been recently presented to both Houses of Parliament, respecting the ships constructed for the Royal Navy during the last twenty-one years, affords some interesting information, which in a great measure explains the continual increase in the total amount of the Naval Estimates. From the paper we refer to, we learn that in 1854 the cost of the hull and machinery of a first-rate line-of-battle ship varied from 112,000*l.* to 156,000*l.*, while the finest frigates afloat were built for from 53,000*l.* to 90,000*l.* Up to that date, therefore, the old rough average, which held good at the beginning of the century, of allowing 1,000*l.* for every gun which a ship was to carry as the cost of her construction, was not very largely

exceeded. But with the ironclad reconstruction of the Navy, which was commenced after the Crimean war, began the rise in the cost of shipbuilding, and in 1863 we find the 'Minotaur' costing 456,830*l.*, while the expense of building the 'Achilles' amounted to very nearly the same sum. Three years later, in 1866, we have the 'Northumberland,' estimated at 471,000*l.*, and in 1868 the 'Hercules,' costing 361,000*l.*, and the 'Inconstant,' an unarmoured frigate, 213,000*l.*; instead of the 53,000*l.* to 90,000*l.* allowed for ships of the same class in 1854. Seven years later on, again, we find the cost of ships still steadily rising, the 'Dreadnought' being put down in 1875 for 508,000*l.*, and the 'Alexandra' for 522,000*l.* This year's estimates do not provide for laying down any new ironclad; but it can hardly be doubted that the next ship we build of this class will be even more expensive, since the cost of the 'Italia,' the money for building which has just been voted by the Italian Chamber of Deputies, is estimated at no less a sum than 600,000*l.* *Broad Arrow.*

We have repeatedly advocated the employment of heavily-armed and thickly-armoured vessels for our coast defence. By sacrificing high speed and contenting ourselves with just sufficient steam power to give these floating forts the means of moving from one part of the coast to another, we could obtain the greatest possible armour protection for the small extent of vital surface to be covered. To transform the floating-fort design into an ironclad fit for European service, and qualified to fight in line of battle, merely requires increased dimensions. What those dimensions should be so as to secure the most economical result, is a moot point; but we feel satisfied that it is not essential to have so large or so expensive a vessel as the 'Inflexible.' We are glad to find that several of the essayists, including Captain Colomb, are of the same opinion. Upon a displacement of about 8,000 tons we feel sure it would be possible to produce an ironclad of about 280 feet in length and 65 feet beam, which could be protected at the vital parts with 24-inch armour, carry four of the largest guns afloat, and steam at the rate of fourteen knots. To do this all armour protection for the guns must be abandoned, but for defence against shell a 3-inch iron deck could be fitted right fore and aft, except where the thick armour is placed. A careful subdivision by an inner bottom, bulkheads, and iron platforms would further reduce casualty from rams and torpedoes to a minimum. July 13, 1878.

Broad Arrow. — February 8, 1879.

By the launch of Her Majesty's ship 'Orion' at Messrs. Samuda's Yard, Millwall, the other day, another valuable ironclad is added to the British Navy. . . .

We have on a previous occasion expressed the high opinion we have of this class of vessel. Having regard to the armament and armour, speed and coal endurance, fighting qualities, and cost of building, we consider that the 'Orion' and 'Belleisle' are not excelled by any type of war vessel afloat. For the sum of about 300,000*l.* one of these vessels can be built, armed and fitted out, so that two can be obtained for the cost of one 'Vanguard,' and more than three for that of one 'Inflexible.' There is ample duty in the Royal Navy for at least six of such vessels. Now that Russia is taking such active steps in arming her naval stations in the Pacific, and in despatching cruisers to that part of the world, where we have so many practically defenceless settlements, it behoves us to maintain on that station vessels of the 'Orion' type, than which none in existence are better adapted for the service to be performed. And not only in the Pacific, but in the Indian Ocean, Australia, and even Mediterranean stations, such vessels are far more likely to be advantageously employed than the 'Invincible' and 'Swiftsure' class, to say nothing of such worn-out specimens as the 'Hector,' 'Valiant,' 'Resistance,' and 'Lord Warden,' or the more respectable members of the 'Warrior' and 'Minotaur' classes.

1879. A vicious system of expert criticism has confirmed us in these errors. No new ship is projected or launched without our having a list of its comparative merits. Its armour is so much thicker than this vessel, its guns are so much heavier than some other vessel's; and so on. Straightway this single ship is regarded as a terror, as being superior to anything elsewhere, and as hugely depreciating all other ships in consequence. In an encounter with two inferior vessels, it might come off second best. Nay, with one vessel of superior speed, armed only with one gun of equal strength to its own three or four guns, it might be worsted. The mathematical certainty only goes with superior armament upon paper. In reality, chassepot and mitrailleuse yield to the less effective needle-gun, wielded by better hands and superior numbers. It must be so in naval warfare. An inferior ironclad, with attendant vessels indifferently armed, might beat a ship infinitely superior in everything that constitutes weight of metal and offensive power. The idea that because A is

vastly superior to B, C, D, E, and F, taken singly, therefore A will beat them in detail, if confronted by them, is very familiar to us as an illustration of the importance of having a vessel like A, if only for moral effect; but it is not borne out by facts, and it is contrary to common-sense. There are always portions of a ship less penetrable than others, and the mistake is in assuming that only these portions would be assailed. An unarmoured vessel might disable a mighty ironclad with one shot cleverly dropped through its decks into its engine-room, or so delivered as to disarrange its steering apparatus, and so prevent its evolutions. In an all-round combat at sea such chances increase precisely in proportion to the number of assailants. Nor is there any attempt made to deny these things. The mischief is done by waiving them all away, in order to impress the world with the tremendous power of some vessel we have, or some other nation has.

In our opinion we have more need of small ironclads, such as can be built and equipped at 300,000*l.* to 350,000*l.* each, than of such monsters as those we have been plodding at for seven or eight years before they are finished. Mar. 1880.

We have committed two very great mistakes during the past seven or eight years by expending our money almost wholly in building a few large unwieldy ironclads and repairing others that are obsolete and useless. The result is that we are scarcely, if at all, better supplied with a Navy than when the late Mr. Hunt entered the Admiralty Office. As Mr. Reed pointed out in the recent debate on the Navy estimates, all the present Government has done during its term of office has been to finish the ironclads put in hand by their predecessors. Even this task has not been wholly accomplished, for the 'Inflexible' is not yet ready for sea. Mr. Reed said, in the same speech, that during the time he was Chief Constructor ironclad vessels were laid down, completed, commissioned, and paid off, but he did not explain how that came about. We do not desire to detract from the credit due to Mr. Reed and Admiral Sir S. Robinson for the energy they displayed when the Shipbuilding Department of the Navy was ruled by them, but if Mr. Reed had stated why speed was attained in his time which is not realised now, he would have killed two birds with one stone. Mr. Reed has for many years been an advocate of the small ironclad which both Sir William King Hall Mar. 1880.

Broad Arrow. and ourselves so much desire to be built for the Navy. It is wholly and solely in consequence of recently designed ironclad vessels being so large, unwieldy, complex, and costly that they take so long to produce. Vessels like the 'Hercules,' 'Monarch,' 'Alexandra,' 'Téméraire,' &c., can be easily built and sent to sea within three years of the date of their keels being laid; while those like the 'Inflexible,' 'Ajax,' 'Agamemnon,' 'Colossus,' 'Conqueror,' and 'Majestic,' occupy from six to eight years before they are of any use to the country. Hence Mr. Reed secured a twofold advantage by building his ships of moderate dimensions. We got our ships quickly and cheaply; whereas now money is voted year after year for the same vessel, and when she is completed it is found that one part of her is six or seven years less modern than another.

We do not imagine that Admiral King Hall deprecates building any large ironclads; at all events he did not say so. His opinion is, however, that 'if one-tenth of the money spent on monster ironclads had been directed to the construction of good gunboats, we should be in a much better state of defence than we now are.' We hardly know what sort of vessel the Admiral means by the term 'gunboat,' the description being somewhat vague and general. It is scarcely appropriate to the class of vessels which Mr. Reed has advocated, and of which he has produced several admirable samples. But Admiral King Hall had evidently in his mind simply coast defence, whereas Mr. Reed's designs are intended for colonial as well as home service, and indeed as much for cruising as for either. The 'Almirante Cochrane,' built by Earle's Shipbuilding Company, at Hull, for the Chilian Government, from Mr. Reed's designs, embodies the views held by that gentleman some years since. We are not aware in what direction he would seek to improve on that type now, but certain it is that offensive and defensive power, combined with high speed, are produced in a higher degree in that design than in any other of the same displacement up to the present time. In saying this, we wish it to be understood that we have chiefly in mind colonial defence and cruising capabilities. For coast and Channel service we prefer the 'Belleisle' type, built by Mr. Samuda for the Turkish Government, and purchased for the Royal Navy with a portion of the six millions. Neither of these can be correctly termed gunboats, nor indeed can the 'Cyclops' and 'Magdala' classes. In fact, only the small vessels of the 'Arrow' class, or, better still, the 'Alpha,' 'Beta,' 'Gamma,' &c., built by Sir William Armstrong for the Chinese, can be strictly described as gunboats. Probably it was upon such little vessels as these that Admiral Hall

wishes one-tenth of the money devoted to monster ironclads had been expended. *Broad Arrow.*

During seven years we have had a large portion of the building and fitting capabilities of Portsmouth Dockyard devoted to the construction of one ship—the 'Inflexible.' During nearly three years Chatham Yard has been busy on the 'Agamemnon,' and Pembroke on the 'Ajax.' In about four years more the two last-named vessels will be finished, and a twelvemonth hence will probably give us the 'Inflexible.' What an enormous amount of energy, skill, and money will these three monsters represent! And how little shall we get after all in return! A torpedo launch might under favourable circumstances settle either of them in a few moments, and destroy the labour of seven years, and the result of nearly three-quarters of a million of money. But even supposing such a misfortune as that does not occur, there can be no getting over the fact that one of these vessels—costing as much as four or five of some years ago—can only be in one place at any time, and that may perchance be just where she is not wanted. And yet we should be sorry indeed to be without such vessels. In fact, we wish we had more of them than we have; or, at all events, we would that we had at present something practically useful to show for the money we have been laying out upon them all these years. What we wish to see is a portion at least of the Navy Vote devoted to the building of other types of protected ships than those with which their Lordships seem so much infatuated. There are two classes which we much require, and here we think may be harmonised the views expressed by Mr. Reed in the House of Commons, Admiral King Hall at the recent discussion, and ourselves in the *Broad Arrow*. We want small ironclads for distant service, and heavily-armed gunboats for coast defence. The 'Inflexible' class is adapted for neither, and we are multiplying the units of that class while the dangers to which our coast, commerce, and colonies are exposed, are left uncared for. Well may Sir S. Robinson be startled at this neglect, especially in not providing armed coaling stations for the fleet in distant seas.

Army and Navy Gazette.

There is no doubt that in the 'Inflexible' and the 'Dandolo' we have types of the most powerful vessels that can be built, but each of them costs about half a million sterling; and regarding the matter from the taxpayer's standpoint, the question arises, do we *Army and Navy Gazette.* June 29, 1878.

Army and Navy Gazette.

get in such a ship as the 'Inflexible' the maximum amount of power for the sum of money expended on her? It is true that the 'Inflexible' is more than a match for any possible antagonist singly except perhaps the 'Dandolo' and 'Duilio,' but is she a match for as many small gunboats, say of the 'Gamma' class, as might be built for the same money? If not, Captain Colomb is right in condemning her as extravagant, and she is equally extravagant if she is more powerful than the exigencies of the service required of her demand. It is in the moderately heavy guns and moderately heavy armour-plating that Captain Colomb finds the most economical distribution of force; and he anticipates more effective work from a broadside of 18-ton or 25-ton guns than from the cumbrous and slow-firing 80-ton guns of the 'Inflexible,' or the 100-ton guns of the Italian turret-ships. There is much to be said in favour of this view. It is impossible to build any large number of 'Inflexibles;' and however irresistible they may be individually, it is always open to doubt if they would happen to be exactly where they were most wanted at the right time, and whether circumstances might not arise which would entail the extravagant waste of power which would be involved in these monsters attacking ships of very inferior qualities which might as easily be disposed of by ships of half their power.

Nautical Magazine.

Nautical Magazine, July 1878.

On loss of 'Grosser Kurfürst.'

The height of folly has been reached in building huge, costly, unmanageable ships. Some day, common sense will resume her sway in the matter of defensive armour for ships as it has for men. An armour-clad ship of ponderous size is, in its inconsistency and inherent absurdity, very much on a par with a knight in armour, cumbered with heavy weapons and compelled to carry about food for himself and his horse. If, instead of continuing the present inheritance of incongruity, the Government were to strike out a new line whereby they should set afloat, instead of one leviathan, half a dozen floating ram gun-carriages, whose bottoms should be their strong part, whose power of offence should be a ram, supplemented by a heavy gun firing over it, or a heavy gun supplemented by a ram, it must be clear that for the money spent the result would be far greater, and that in the event of casualty, the loss of men and of money would be trifling.

FRENCH AUTHORITIES.

General Paixhans.

THIS is the Paixhans system, as stated in the General's original work, and in the subsequent exposition; in both of which the essence is declared to be, to avoid the error of building large ships, and the equipment of any ship so extensively for shell-firing as necessarily to expose her to the greater risk she would thereby run of being set fire to, or blown up, by her own weapons. It is added that the effects of this system upon an enemy consist rather in the destructive powers of a few *canons-obusiers*, in comparatively small and swift vessels drawing little water, than in accumulating many in the same huge ship. Into these extremes, however, both France and England have rushed, but England furthest, in rivalry to each other: out of so expensive, dangerous, and extravagant an extreme, both may hereafter have occasion, if the General is right, to retrace their steps. . . . *Sir Howard Douglas.* — Naval Gunnery.

Guns which fire shells horizontally will destroy any vessel, and will do this with a greater certainty in proportion as the vessels are large, because the circulation of powder and projectiles during an action, being more multiplied for the service of a greater number of these guns, will multiply the chances of an entire explosion of the ship. From this fact results the important question whether, instead of concentrating in a single ship of 80 or 130 guns and 1,000 men, and exposing that large quantity of military and financial power, and that amount of lives, to perish suddenly, it would not be better, from motives of humanity and considerations of economy, to lay out the same sum of money in constructing two or three much smaller vessels, which might together carry the same amount of armament and the same number of men? Our principal ships, being then far less enormous and drawing less water, may enter a greater number of our ports, which at present are limited to five, accessible to large *General Paixhans.* — Letter published in th *Moniteur*, February 1854. Quoted by Sir Howard Douglas.

General Paixhans.

ships. The construction of three smaller vessels would neither require so much time, nor timber, nor be so costly. Our fleets would then find at home, and in our colonies, more ports of refuge accessible to them, and they would find more points accessible to attack on the coasts of the enemy. The battery of a frigate may, as well as the battery of a large ship, carry the means of keeping at a distance or of destroying an enemy. In the combat of two or three such ships against one adversary of colossal magnitude, the latter may doubtless, if near, be able to destroy either of the others singly, but these might concentrate upon him, at a distance, mortal blows, and remain masters of a field of battle from which the greater ship will have disappeared.

Committee on French Naval Estimates, 1878.

Committee on French Naval Estimates, 1878.

M. Bethmont, rapporteur.

If the thickness of armour has been doubled, trebled, and even quadrupled; if the first-class ships of the present day are protected with 18-inch, 20-inch, and even 24-inch plating, the power of the gun has been developed in equal proportions.

Three years ago it was anticipated that 80-ton guns would be manufactured. We see to-day that Italy is arming the 'Duilio' and the 'Dandolo' with 100-ton guns, and no sooner has England made preparations for the production of a 120-ton gun than Germany announces a gun of 160 tons; where are we to stop in such a race, who will at last come off victorious in the duel between the gun and the armour-plate? Have we heard the last word of scientific gunnery; and may we not anticipate that the striking illustrations of destructive power which have been afforded in the experiments at Shoeburyness, Essen, and Spezzia, will be surpassed by future performances? . . .

The type of ship which is in vogue to-day makes that of yesterday obsolete. The progress of invention is even more destructive in its effect than the lapse of time. The alternations of the constant struggle between the gun and the armour plate lead to constant changes in the systems of naval construction; and thus, in order to combine high rates of speed with armour protection of ever-increasing weight, we are led to the construction of ships of an enormous tonnage.

In former days a three-decker of the line cost 180,000*l.* In 1857 the price of an ironclad ship was 350,000*l.* The average cost in 1871 was 320,000*l.* At the present day it may be set at 560,000*l.*;

and we shall shortly see an expenditure of not less than 800,000*l.* on individual ships. The armour of 1857 was six inches in thickness. In 1871 we had nine-inch plating. The armour of the present day varies from 18 inches to 20 inches, 22 inches, and 24 inches in thickness.

Is it not desirable to arrest a movement which is leading us to such enormous expenditure for a single fighting ship?

Your Commission, gentlemen, without expressing an opinion on this grave question, considers it its duty in the interests of public economy to bring it prominently under the consideration of the Minister of Marine. They know that France must not allow herself to fall behind in the race with other nations, and the votes which they propose to accord to the Minister are a testimony of their patriotism. At the same time they cannot but observe, that, if the French constructors have been the first to design protected ships, and if their inventive genius created these novel and powerful instruments of naval war, yet on the other hand, during the last six years, other inventions have been brought forward in rapid succession, all tending to make ironclad vessels in a high degree vulnerable, and to destroy their relative value in naval warfare.

We have, first, the ram, which at Lissa in an engagement which will be for ever memorable, enabled an iron ship of little value, but commanded by a brave and gallant officer, to destroy a first-class ironclad. Next, we have the gun, which, with the calibres which have recently been adopted, is capable of destroying with a single shot a vessel which had cost 400,000*l.* Finally, we have the terrible and as yet undeveloped power of destruction of the torpedo, and the torpedo-boat.

Admiral Baron Grivel.

When we reflect that a few pounds of powder inclosed in an iron vessel are sufficient to annihilate the largest ironclad, which it had cost years and hundreds of thousands of pounds to produce, does it not seem as if the Almighty had wished to deter men from engaging in a reckless competition in the invention of the means of mutual destruction? Does not the torpedo, like the sling of David, seem destined to play, in the sacred dispensation of Providence, the part of the avenger of the weak against the strong?

Admiral Pothuau.

Minister of Marine.

Debate on Naval Estimates, 1879. Chamber of Deputies.

If we have followed rather than led the way in the policy of constructing ships of the vast dimensions which have found favour with other naval administrations, it has been because for a considerable period it was believed to be unwise to go beyond the dimensions of the 'Duperré,' that to exceed those limits was an exaggeration, and the more so because it was in contemplation to throw off armour altogether.

Admiral Touchard.

Admiral Touchard.

Encore la Question du Décuirassement.' Paris, 1876.

What becomes of the 'Gloire,' the first-born of the armoured battle ships? Sixteen years have passed, and a type by no means old is already obsolete. Protection has been doubled and tripled by increasing the thickness of the armour to from twelve to fourteen inches, but the sacrifices have been great. The displacement has been increased, the draught of water has been increased to prevent exaggeration in length. In displacement, in draught of water, in protection, the utmost practicable limits have been reached, if not exceeded; and to build one of these costly ships the expenditure has been piled up by millions and millions. And what is the result of all these efforts, and of this expenditure? The gun remains master of the situation, and will pierce this *impenetrable* armour at a distance of from 1,100 to 2,200 yards.

From *La Question du Décuirassement*: passage translated in Mr. Barnaby's speech in the discussion on his paper on the 'Hotspur-Glatton' experiment. March 26, 1873.

I have here a brief extract from a very interesting article which has been published in the February number of the *Revue Maritime*, by Vice-Admiral Touchard, who occupies a position in France corresponding to that of the Controller of the Navy here, and with your permission I will read a few extracts from that, freely translated, and with certain omissions. Referring to the 'Gloire,' 'Marengo,' 'Hercules,' and 'Koenig Wilhelm,' he says:—'These, then, are the instruments for fleet-fighting of to-day. Is it to be believed that they will continue to occupy the first position, that they will be the *ne plus ultra*? No, for the gun goes on always increasing in power; and in France, as in England, Russia, and Prussia, we are no longer contented with guns of 10 and 11 inches, we go up to 12 and 13 inches, and there are laid down in the dockyards ships for fleet-

fighting plated with armour from 9½ to 12 inches thick, and from 9,000 to 10,000 tons displacement. Where shall we stop in this strife? Where will it end? I see the end' (he goes on to say) 'in the abandonment of armour for the guns.' Sooner or later this will be the end for the 'navire d'escadre,' or, as we should call it, the armoured cruising ship. 'Let us admit if you will,' he says, 'that the battery should for the future be plated with armour of 10 inches, as it soon will be, the question of abandoning it will nevertheless be resumed upon these two considerations:—1. Is battery armour of 10 inches penetrable? 2. If it is penetrable, does it not become rather a danger than a protection?' And then he goes on to say:—'And now let us see what will take place in a battle between fleets. The two squadrons being in order of battle, if both freely accept the contest, there will be collision by ramming, either with or without preliminaries. In any case it will suffice that one of the two should be resolved for it to make ramming the first act; let us mark the opening phase of the fight. The combatants advancing towards each other would be ranged in one line, or in several, or in squadrons; but, whatever be the order of battle, there will be formidable collisions and grinding of the sides; they will cross each other's course, and then, putting the tiller hard over, will return to the encounter. Again will they strike and again pass on. Woe to the vessel which, disabled by the first attack, or turning less quickly than her adversary, exposes her flank! Like the "Rè d'Italia" at Lissa, she will be sunk by a single blow.

Admir
Touchar

'It is here—in this initial phase—the ships perpetually fouling each other, that the gun appears on the scene in all its might. The manœuvre is foreseen. A single order, clear, concise, energetic, follows in three words, "Prepare for ramming." At this command, the guns are pointed low; the captain of each, his eye fixed on the sights, with bent body and extended arm, waits! He watches the moment when his adversary will pass before the muzzle of his gun—the moment, fleeting as the light, which he must seize for firing. Silent and motionless each man is at his post, but lying full length upon the deck. The Captain alone remains erect; suddenly the guns and musketry burst forth, and the vessels crash into each other with their sharp-pointed prows, and gliding by each other prolong the contact along their sides until they reach their sterns, which they avoid in order to protect their rudders and screws. After this first encounter, the combat will always be carried on at a short distance, if not broadside to broadside, the gun and rapidity of evolution playing the principal *rôle*.

Admiral Touchard.

'In this strife of vessels, let us take two opponents. The first is an armour-plated cruiser, with 9½-inch plates on the battery, which will soon relegate the actual vessel to the second rank;—9½-inch plates on the battery is the thickness which has actually been adopted for the most recent design of the French Government;—it is armed with 12-inch or 12½-inch guns carried in two divisions, *i.e.*, two or three on each side. This is a small quantity, but the more the weight and calibre are increased the more the number is diminished; thus it is that the 120 guns of our old three-deckers are represented—I might almost say combined—in the armour-clad cruiser by 8 or 10 guns. Now with regard to the military value of a gun, its efficacy does not wholly consist in the size of its bore; of what importance is a large shot if it does not attain its destination? In the vessel of 120 guns the loss of a single badly-directed shot is comparatively nothing; in armour-plated ships the loss of a single shot of the eight or ten which I can fire is a great deal. For each of these great guns ample fighting-room is necessary in order that it may be freely and rapidly manœuvred; above all, it is necessary that the gunner—the soul of the gun—in the midst of these evolutions, these tournaments of warfare, should always see the object of his aim, always follow it with his eye, to strike it at the favourable moment. Is this possible through the narrow frame of a porthole full of smoke and quite filled by the muzzle of the gun?

'But this is not all. This central fort, with its side armoured with plates 9½ inches thick, is not impenetrable in all the phases of this fight, and at all the distances. It can be pierced by the enemy's shot, and without doubt such will be the case. Imagine what effect will be produced by one of these projectiles penetrating the central fort, there bursting and projecting before it a murderous cone of fragments of wood and iron. The space is confined, the guns are disposed in two lines, starboard and port; the men are crowded. Everything will be cut down, overthrown, destroyed—not a man will remain erect, not a gun in a fit state for firing. "All will be over," was said to me by one of our officers, who during the war commanded one of our most powerful armour-clads.

'Of what service, then, is this cuirass from the moment when it is penetrable. Far from being a protection, it is a danger, and it only interferes with the fire of those guns which it is powerless to protect.

'Of the two adversaries whom I have considered the second is unarmoured.' (Admiral Touchard's view, in what follows, is not at all the view I have taken.) 'It has the same number of guns as the

first and of the same calibre, but, instead of being concentrated in two lines in a battery, these guns are disposed *en barbette*, on a carriage with a central pivot, occupying a single line amidships in the fore-and-aft plane of the ship,'—an impracticable arrangement, as I venture to think. 'There they are, in the open, in full sight, commanding the whole horizon. The advantages of this arrangement, viewed with regard to efficiency, are very striking. In lieu of the training space, limited and almost annulled by the narrowness of the ports and the size of the guns, there is substituted for each piece a training space extending from side to side, while the glance of the gunner in full possession of the horizon ranges freely and uninterruptedly over the object to be attacked. There is another view in that inevitable phase of the combat in squadron which for an instant —and that a decisive one—places the combatants side by side: she brings the whole of her pieces into play, whilst the ship with a battery can only oppose a half. Thus it is that, to the broadside of three guns from the battery, the ship without it can oppose six guns of the same calibre. *Admiral Touchard.*

'Thus in the double light of the number and proper direction of the shot, of their efficiency, the advantage belongs to the second vessel, to that whose artillery is not cuirassed. But this is not all. By suppressing the plated battery a great economy of weight is accomplished, and this economy if entirely applied to displacement permits a diminution in the length of the vessel, to the great profit of its powers of evolution, so that, other things being equal—that is, with the same speed, the same handiness in manœuvring, the same sail power and armament—the one ship will turn quicker in a smaller circle; now, to turn quickly in a small circle is the *cardinal* faculty in an engagement with prows.

'Thus, in conclusion, the vessel without an armoured battery will cost less, be more handy, more capable of evolution, and its offensive power, considered with respect both to the gun and the prow, will be notably increased.

'I stop here. After having put two adverse squadrons face to face, I have detached two vessels from the group of combatants, both equally protected at the water-line, both armed with guns of the same calibre and equal in number. In the one case these guns are covered—I can no longer say protected—by an armoured wall; in the other they are exposed, or merely masked by a movable screen of steel plates which protects the gunners from musketry. These ships I have opposed to each other, and by bringing before the eyes of the reader successive phases of the combat, I have endeavoured to show

Admiral Touchard.

that the advantage should belong to that whose guns are unprotected, it being thoroughly understood that I only speak of *lateral* protection. The principle of a combat "end-on"—that is to say, by ramming—being admitted as a consequence of the spur, and as the base of naval tactics, the *longitudinal* protection deduces itself; this is obtained by means of an armour-plated transverse bulkhead placed forward, or by some other analogous disposition. As it is not my object to define the means, I confine myself to simple indication.

'It should thoroughly be borne in view that I have taken care to define the nature of this inquiry; I repeat, it is only a question with regard to cruisers as to the amount of protection and of the artillery they may carry. Were it a question of coast defence vessels, it would be quite another thing. The coast defence ship may pretend to invulnerability (long though the word is, it may well be employed to express the thing)—it can pretend to it especially on account of its form. The cruising ship cannot pretend to it; at the most it will only obtain a *relative* invulnerability, that is to say, dependent on the distance of the combatants and the direction of the shots. But in a fight between cruisers, as I understand it, the distance will in no case exceed what I have termed "*fighting distance*," from 1,000 to 1,300 yards, and in that initial phase, which I have called the *decisive* phase, the greater part of the blows will strike square to the surface. If, then, anyone claims for the cruiser relative invulnerability, I may be allowed to refuse him the benefit of it.

'If it be true, on the other side, that as against the cruiser as it at present exists, either afloat or building, the gun has definitely asserted its superiority, there are only two possible solutions of the fighting ship—the mastless ironclad, such as the "Devastation," or the Russian monitor "Peter the Great," and ships masted but without protection for the artillery. These two types combined—armoured ships without masts, masted ships without armour, mutually aiding and assisting each other—will form probably the fleet of the future, but that which from the present time can no longer be doubtful is, that the masted armour-plated ship of war will no longer figure there.'

Before sitting down I may refer to an announcement which has just appeared in the newspapers to the effect that the newest design of the French Government produced under this gentleman's auspices has eight armour-piercing guns only,—she is the same size as the 'Superb,' viz., of 9,000 tons displacement. Four of those guns are left to fight in the open without armour. For the protection of the other four, the weight of armour taken would increase the weight of

the armour required for the protection of the hull by 50 per cent. For the protection of four guns out of the eight, half the entire weight of hull protection has been taken, and the thickness of the armour protecting those guns from right-ahead fire is equal to the thickness of the armour for the protection of the hull. It is clear, therefore, that Admiral Touchard has no more been able to get rid of the armour in front of his guns than we have. Having placed the questions before you, I will now leave them to be discussed. *Admiral Touchard.*

M. Dislère.

What are the conditions which the seagoing line-of-battle ship shall be called upon to fulfil? This is what we shall endeavour to determine. Perhaps we ought rather to say that we shall repeat a statement already put forth by the highest naval authorities. To mount on a hull of a given displacement the most powerful guns, and in numbers appropriate to the dimensions of the ship which is to carry them; to secure for the guns ready means of training in all directions, and especially to obtain an effective bow-fire; to protect the armament in such a way that the area of the armoured side necessary to cover the guns should be as small as possible, and thus, with a given weight, to have armour of the greatest possible thickness; to give to the ship the highest evolutionary qualities, and to give effectual protection for the rudder, to secure for the ship as ample a coal supply as possible; lastly, to combine with all these conditions the indispensable sea-going qualities of sea-worthiness and habitability,—such is the long enumeration of the qualities we desire to secure in the battle-ship, which has taken the place of the old ships of the line as the unit of a naval force. *M. Dislère.* *La Marine Cuirassée*, pp. 197–200. Paris, 1873.

Certain it is that all the qualities which have been enumerated cannot be combined in the same ship. The most recent experiments tend to show that armour with a thickness of less than sixteen inches is useless as a protection, and if it does not protect, it is positively detrimental, and ought to be laid aside.

Let us further consider what a heavy price we have to pay in order to obtain an armour protection, which will probably have become nearly useless for its purpose before the ships which are in construction can be launched. The 'Devastation,' although protected with armour only twelve inches in thickness, is the first example of the compromises and sacrifices of all kinds, in which it is necessary to acquiesce. The investigations made in France have shown that

M. Dislère. to do more than the English constructors have accomplished in the 'Devastation,' it was absolutely necessary to surrender qualities of vital importance; and to increase the dimensions to such a degree that every ship would cost at least 500,000*l*.

We therefore consider it impracticable to continue to give protection by means of armour to our battle-ships, and we are of opinion that by giving up a vain and hopeless attempt we shall be spared a large and unprofitable expenditure.

In considering, however, the relative value of the mass of iron which at the present day burdens the sides of our armoured ships, we must draw a distinction in the value of armour, according as it is applied to the more or less vital parts of a ship of war; if, as it is probable, a radical change is not accepted, we must decide in what order we shall successively relieve ourselves of the useless and injurious burden we are required to carry. We may endeavour to protect, first, the guns and the gunners; secondly, the steering-wheel and the helmsman; thirdly, the communications with the magazines, the mechanical gear for training, the engines, the boilers, and the magazines; fourthly, and lastly, the ship itself. As for the artillery, we consider that all weights employed for its protection are completely thrown away, for this all-sufficient reason, that it is impossible to give an effective protection, and that the desire to protect the guns involves the necessity of crowding them together; in other words, leads to an arrangement of the armament which makes it in the highest degree probable that all the guns might be silenced by a single broadside.

Those observations do not apply to the steering-wheel and steering-gear. These are of vital importance to the safety of the ship. It is indispensable that they should be effectively protected; and this can be accomplished with a comparatively moderate weight of armour. With regard to the engines, boilers, and magazines, by placing them low enough in the ship they can be protected from the effects of shot by the same means which are employed to ensure the safety of the ship itself.

The English Committee on the Designs of Ships of War reported in 1871 that the ship of war of the future would probably consist of a very strongly armoured battery surrounded by, and floating upon, an unarmoured raft, divided into compartments, containing some light substance such as cork, in such a manner that it would receive no injury and could be penetrated by projectiles without fatal consequences. The first suggestion, that of a strongly armoured citadel, does not commend itself to us; and we have already given our

reasons. Their second suggestion was only vaguely shadowed forth in the Report of the English Committee; and the labours of Mr. Reed in England, and of M. Bertin, the Naval Constructor in France, were necessary to show the possibility of securing an effectual protection for battle-ships by the means proposed. The subdivision of a ship, so to speak, into three horizontal strata or sections, the lower part containing the machinery and provisions, covered by a double deck, the intermediate space being divided into compartments, and protected with armour, and the upper works forming a battery armed with guns *en barbette*,—such seems to be a general outline of the true type of fighting-ship. It will be admitted that there are many questions which still await solution. In the first place, we have to consider the probable effect of projectiles on compartments filled with cork; and we can only express the earnest hope that experiments will soon be undertaken, which will throw some light upon this interesting problem, and enable us to adopt an improved system of construction, more in conformity with the resources at the disposal of the naval architect. We do not disguise from ourselves, moreover, that the adoption of this principle of construction will necessarily lead to a complete alteration in the armament of the different navies, and that we are destined to see the rapid substitution of numerous guns of small dimensions for a small number of very heavy calibre. *M. Dislère.*

We have throughout this discussion set aside that new element in naval war, the torpedo, which is destined to bring about, in tactics, a revolution not less complete than those which have been brought about in succession by the introduction of steam, the rifled gun, armour, and the ram. We have no longer to take into account merely the stationary torpedo, exploding on contact, or by electricity, which will be laid down in the middle of the channels as a means of defence, or may be allowed to drift down with the current of a river. The torpedo has become automatic. It can now be used to attack an enemy. It is no longer necessary, as in the civil war in America, to send out a boat manned by intrepid and devoted men upon a hazardous expedition to dash the torpedo against the side of an enemy. The torpedo can be steered from a distance against the object. In battle it can be discharged from the side of a ship, either above or below the water, thus realising the problem, the solution of which has so long been sought, though without success, of a subaqueous gun. Unseen, it will strike the object at which it is aimed, and will accomplish, without danger to the ship which has fired it, that result which it is so difficult to attain with

M. Dislère. the ram, which is always so full of peril for both combatants in the fight.

Being now brought face to face with this new engine of war, we ask ourselves, Does the armoured ship possess any advantages? What will be the value of the heavy coat of armour, for which so many nautical qualities have been sacrificed, and which will have increased the price of the ship to such an extent that for an equal expenditure two ships instead of one might have been brought into the line of battle? Will this armour afford any protection whatever against the terrible catastrophe which threatens? Examining the subject from this point of view, we are once more brought to the conclusion that armour is destined, at no distant day, to disappear from the sides of our battle-ships.

The old adage has often been repeated, the truth of which we have only learned too well, *Si vis pacem, para bellum.* We must, without needless haste, select from the means of action at our disposal those which are most appropriate. A day will come when our fleets will again be required for active service, and when, laying aside the abstract ideas of philanthropy which we have been taught to forget by recent and bitter experience, it will be necessary to despatch to every sea cruisers, we would rather say corsairs. Coast-service ships will once more be required to defend our own shores, and squadrons of battle-ships to meet the ships of the enemy in the broad sea; but whenever the conflict is renewed we are very confident it will not be by armoured ships that the honours of the National Fleet will be sustained. It is that fleet of the future which without delay it is necessary to design and to build.

We have not taken into view the coast-defence question. We have dealt with it in a former treatise. With regard to the armoured battle-ship, it is, in our view, completely a thing of the past; and when we undertook to write the descriptions of ships which are contained in the present volume, we were led to do so by the belief that no time should be lost in accomplishing our task if we wished to complete it before the death-warrant of the armoured ship had been signed.

Guerre d'Escadre, pp. 184–86. Paris, 1876.

If for a sum of 1,500,000*l.* it is possible to construct 30,000 tons of displacement, is it better to apply the expenditure to the construction of three ships of 10,000 tons or five ships of 6,000 tons? This is how the problem should be stated. It is evidently idle to

think of applying to a ship of war any calculation as to the return upon an invested capital, or to consider the question in the same light as works of public utility, such as roads or railways. The return in this case must be considered not as an absolute but as a relative quantity. Calculation may be made for a certain class of ships, with reference on the one hand to the chance of preventing penetration by armour protection or avoiding the ram by their handiness; and on the other hand with reference to the elements of power which they derive from their speed, their coal supply, and their armament, whether in chase of an enemy or in the line of battle. We may proceed to establish certain coefficients, as representing the importance which may be attributed to these different elements of power. The results thus obtained may be massed together, and the total divided by the cost of the ship. In this way we may establish the basis of a calculation of the comparative return upon the capital employed in the construction of ships of the various classes, whether for the line of battle, coast service, or as general cruisers; and it appears to us almost certain that an inquiry of this nature, with reference to ships of from 6,000 to 10,000 tons, would show that there is a decided advantage in a considerable reduction of displacement. *M. Dislère.*

It must not be forgotten that in naval construction, as in politics, everything is more or less a matter of compromise, and that it is by a wise sacrifice in some points that it is possible to obtain other, and perhaps more essential qualities in a vessel of war. No doubt it would be preferable to make every ship a complete and most powerful weapon of war, to mount the heaviest armament; to secure the highest speed and to combine these qualities in a handy and inexpensive vessel. But inasmuch as these requirements are antagonistic to one another, we must provide for them according to our estimate of their relative importance, and without completely sacrificing any quality which should be embodied in a vessel of war. In the first rank we should place two qualities, which are practically corollaries to one another, that is to say, a high evolutionary quality and a comparatively moderate displacement. The offensive power comes next, including armament and a moderate speed. Lastly, we shall seek to protect the vital parts of the ship, the commander, the steering-wheel, and the hull, below the water-line. Mr. Samuda, during the debates on the English Naval Estimates in 1873, when asking for protection against common shell, insisted that ships should be protected by five inches of armour at the water-line; that they should have a speed of 16 knots, an armament of eight guns, and

M. Dislère. should carry four torpedo-boats. Common shell, however, have now fallen into disuse, and we have to deal with shell which burst as they penetrate the armour, and which in penetrative power are little, if at all, inferior to solid shot. In this case, 5-inch armour would be altogether illusory; and we must insist upon a thickness of not less than from eight to ten inches in order to resist at point-blank range the projectiles of all guns of 15½ tons weight. Armour of the thickness specified will keep out the projectiles of guns of weights not exceeding 23 tons, at a distance of 1,800 yards, assuming that the projectiles strike the plates at an angle more or less oblique from the perpendicular. The armour for the decks should be sufficient to give a protection not less effectual than that provided for the water-line. The most important hatchways, the lower part of the funnel, and the conning tower should be equally protected. A very powerful armament, including a fair number of guns of various calibres adapted to the manifold exigencies of naval warfare, and mounted in such a manner as to make the best use of any opportunity of firing upon the enemy when passing broadside to broadside, a speed of 14 knots at the measured mile, a satisfactory coal supply and a good spread of canvas, ought to be combined in a displacement reduced to from 6,000 to 7,000 tons. With these dimensions, excellent evolutionary qualities might be secured.

Description of the 'Italia' and 'Lepanto.'

It is now certain that the 'Italia' and 'Lepanto' will cost fully 289,000*l.* It is possible that in regard to displacement, this will be the last development of naval construction, and that instead of seeking to produce marine colossi, a return will be made—in displacements of 8,000 tons—to the dimensions of manageable ships, and to such a reasonable limit of cost, that our entire resources will not be at stake in one or two ships the success of which must be admitted to be more or less doubtful.

La Marine à l'Exposition de 1878.

The price of the 'Amiral Duperré' is, for hull and engines complete, 12,850,000 francs. . . .

But the *money cost* of this great fighting unit is not the only sacrifice of great importance which it entails. Is it not also proper, to arrive at a correct estimate of the whole question, to take into account the expenditure of time required for the construction of so vast and complicated a machine? . . .

The new design of 1876 cannot be ready before 1881. . . . If it should be found possible to carry out another design for a smaller fighting unit, costing for instance one-half less and capable of being completed in three years, faster and handier, armed with a smaller number of heavier guns, may it not be maintained that two such ships as this latter would represent a fighting force superior to that of the armour-clad which would have been formidable in 1876, but which will not be so, in anything like the same degree, in 1881? *M. Dislère.*

Vice-Admiral Penhoat.

If we consider the ship of the line with special reference to the armament, we naturally give to such a vessel the most powerful guns that have been manufactured. But in order to realise such a desideratum, the dimensions must be increased in proportion to the heaviest weights which the ship may be called upon to carry. *Vice-Admiral Penhoat.* *Éléments Tactique Navale*, pp. 254. Paris, 1879.

Are we quite sure that it is judicious to attempt an endless journey forwards, in the progressive development of the power of the gun and the thickness of the armour? It is clear that there is a point which cannot be passed without prejudice to the sea-going and evolutionary qualities of the ship. The displacement must not be allowed to increase when that point has been reached.

It is scarcely possible to admit that sea-going ships of the line can carry armour of a thickness exceeding fourteen inches, and retain the qualities of a seaworthy and handy ship. . . .

When two hostile fleets stand face to face, it is well known that at the commencement of the action the ships on either side will make a charge and attempt to ram one another. It is only at the instant when the ships meet and pass, broadside to broadside, after the attempt to ram, that the guns can be brought into action with effect, and always at close range.

Important as it is to increase the armaments of ships, they cannot be carried beyond a certain point without detriment to the evolutionary qualities. The inevitable result must therefore be that the ship will be at a disadvantage when attacked by rams and sea-going torpedo-boats, small in size but superior in numbers.

Looking to the line-of-battle ship, and specially in regard to its fitness for engagements with the ram, it is clear that ships of this class should be moderate in displacement, and that it should be our aim to multiply their number, so as to increase the number of rams which the fleet can bring into the line of battle. Whatever be the

Vice-Admiral Penhoat.

size of a ship, it can have but one ram, and the ram of a large ship will not be more effective than the ram of a small vessel, the weight of the latter being sufficient to give a fatal blow to the most powerfully protected adversary. Indeed, the small ship may have an advantage over its larger opponent in the superiority of its evolutionary qualities. It follows from these considerations that armoured corvettes may be good rams.

Vessels armed with the spar or towing-torpedo, capable of taking their place in the line of battle, do not require large dimensions, in order to be effectively armed. The torpedo armament seems specially adapted to the first-class cruisers, the armament of which is comparatively weak, and which cannot, without danger to themselves, attempt the use of the ram.

Rams and sea-going torpedo-boats must have great speed and rudder-power, in order to use with effect the weapons with which they have been provided.

To sum up: the power of a ship of war in guns can be increased step by step, by increasing the displacement, so as to enable the vessel to carry more and more powerful guns, with proportionate armour protection. It is otherwise with the ram and the torpedo. The power of each of these weapons cannot be increased by enlarging the displacement of the ship; while on the other hand, by multiplying the number of vessels of these two classes, the strength of the fleet, in a combined attack, may be increased.

AMERICAN AUTHORITIES.

UNITED STATES.

PROFESSIONAL AND OFFICIAL AUTHORITIES.

Admiral Porter, U.S.N.

NOR can any ship be considered a complete fighting vessel, unless she be able to ram her antagonist; and it will be found, in the event of war between two great Powers, that the fleet possessing the best rams—other things being equal—will win the battle.

Admiral Porter.

Report for 1874. Power of ram in naval warfare.

When the fight commences, and the ships are enveloped in smoke, it is evident that rams and torpedo vessels will have matters pretty much their own way, and the more smoke there is the better it will be for them.

Mr. Robeson, Secretary U.S.N.

Mr. Robeson, Secretary of the United States Navy. Annual Report for 1874:—'Our circumstances do not require that we should take part in the rivalry between monster cannon and impenetrable armour, since few of our ports are accessible to ships carrying either, and these may be better defended by attacking the vessel below her armour, by sub-aqueous cannon—movable and stationary torpedoes.

Mr. Robeson.

Report, 1874.

'The general professional opinion of the Navy is that the offensive torpedo can be most effectually operated from swift unarmoured vessels, some of which would escape the hostile guns, owing their safety to their small size and rapid manœuvring.'

From the Report of the Secretary of the U.S. Navy, 1877-78.

Secretary U.S.N. — Report for 1877.

This Department has not ventured to propose an inexpensive, and what would, in all probability, prove an ineffective attempt to copy after, or to design and build, these costly vessels, which in commission are enormously expensive, and, whether in service or laid up, undergo rapid deterioration.

Whenever the condition of the Treasury will justify appropriations for the purpose, it is supposed that, instead of the large and expensive ships which the European Powers are now building, our necessities may be, in a great measure, if not entirely, met by well-constructed vessels, well-designed and swift marine rams and improved torpedo-boats, endowed with such qualities and built in such numbers, at comparatively small cost, as our existing necessities may demand. Experiments in these are suggesting their great value as the means of aggressive warfare, and there is fair promise that they will, in the course of time, supersede the expensive naval architecture which so enormously swells the cost of some of the largest ships. Heavy armour-plated, gun-bearing vessels are not capable of sea-service.

They are suited for but little else than harbour defence, and may be likened to movable fortifications. And if it shall result that the use of them shall be dispensed with to make place for improved ships, rams, and torpedo-vessels, then the Navy can become sufficiently effective if supplied with fast-sailing and fast-steaming vessels of different classes, built as they are now built elsewhere, to serve in time of peace as schools of instruction for our seamen, and in time of war to destroy the commerce of an enemy.

Mr. King, Chief Engineer U.S.N.

Mr. King. — *European Ships of War*, p. 287.

A torpedo, so long as it hits, no matter where, would dislocate the integrity of the ship, within an area large enough to prove fatal. The larger the vessel, the more likely it is to fall a prey to the torpedo or the water-rocket. Its size would render it more susceptible to attack, and its slower speed would make it more difficult to get out of the way of an active enemy. Smaller ships, therefore, would seem a necessity of the time, leaving details of construction for further consideration.

Quoting from the *Times*, Mr. King says:—'Some very interesting experiments were made a few days ago at Cherbourg with the little torpedo-vessel called the "Thornycroft." . . . The steam-tug went at fourteen knots an hour, going at full speed, in order to escape the "Thornycroft." The latter went nineteen knots an hour, a rate not attained by any vessel in the squadron. The chase lasted an hour. . . . It is evident that a single boat of this kind would be unable to approach an enemy's ship, unless at dusk. . . . On the other hand, it would be quite impossible for one or even several ships to defend themselves against a simultaneous attack, say by twenty or twenty-five "Thornycrofts;" and as these cost only the fiftieth part of a man-of-war, this experiment presents a formidable problem to State navies.' *Mr. King. European Ships of War, p. 238.*

In view of the value given to small fast vessels by the invention of the self-moving torpedo, and the risks to be encountered from this terrible weapon, as well as the ram, it is not probable that hereafter any war-vessel will be built larger or as large as the 'Inflexible;' but it is reasonable to anticipate heavier guns in less numbers mounted in vessels of smaller dimensions. *European Vessels of War, p. 255.*

Considering these facts, any administration may well pause before it sanctions the expenditure for such a vessel of three or four millions of dollars.

'*Inflexible.*'

It is impossible to secure immunity from risk in battle. The 'Inflexible,' like the 'Nelson' and 'Northampton,' having unprotected ends, as well as other British armoured ships, if engaged by a powerful enemy, will encounter greater risks of being sunk from the attacks of rams and torpedoes than from the effects of artillery fire. Observations on H.M.S. 'Inflexible.'

Commodore Simpson, U.S.N.

'It must be borne in mind that in target practice we note the effect that is produced under the best possible conditions for the gun. The target is set up at short range, generally not exceeding two hundred yards, and the line of fire is at right angles to the surface struck. . . . The forward part of all rifle projectiles is so shaped that a slight angle at the point of impact interferes with penetration by deflecting the missile, and this effect would preserve the hull of *Commodore Simpson. United Service, February 1880. 'Wants of the Navy.'*

Commodore Simpson.

a vessel from injury much more than would additional thickness of armour if struck perpendicularly. . . .

'Although a certain thickness of armour, then, is absolutely necessary to protect a sea-going fighting ship from modern artillery, we should abandon the effort to make the ship invulnerable under all directions of fire; for by persevering in this effort we make it impossible to construct ships of moderate size, thus expending on one vessel what would provide us with two or more smaller vessels, which would render better service.

'What do we see as the practice of other maritime people who stand as our equals as great nations? We see that every ship flying the flag of a commander-in-chief is an ironclad cruiser. . . .

'The vessel that we will set up as the type for our ironclad cruisers, to form, when assembled together, our ironclad cruising fleet, is H.B.M. ship "Alexandra."

'We select this vessel because she is a ship with her battery mounted on broadside, for we would dismiss the idea of associating a movable turret with a sea-going ship of war. The "Alexandra" has a broadside battery, but, at the same time, she possesses the advantages of a turreted ship in having an all-round fire, which, after all, is, with one exception, the only argument in favour of a turret.

'We seem to have in the "Alexandra" a most happy combination of advantages.'

The ship has a battery of twelve guns, eight of which constitute her main-deck battery, and four are mounted in an upper battery, which is situated over that portion of the main-deck battery in which are contained the six after-guns. The forward iron bulkhead of the upper battery is continued down through the main-deck battery, dividing it into two parts, thus leaving the forward guns of the main-deck battery in a compartment by themselves. The means provided for giving these guns an opportunity for delivering an end-on fire, by the tumble in form given to the sides of the forward part of the ship, is one of the refinements in the construction of ships of war which has been worked out by experience.

Now we propose this ship, this construction throughout, as a suitable model for adoption, with but one reservation, and that is in the *thickness of armour*. Of course, a reduction in the weight of armour will reduce the dimensions of all the parts, and that is just the object that we would have in view; and if we reproduce on a reduced scale such a ship as the 'Alexandra,' we will have all that we can desire in the shape of an ironclad cruiser. There is no doubt that by reduced length and beam we will have a *handier* ship, and

we believe that the reduced thickness of armour will still supply us with a vessel that may be relied on in action, *in all its varying phases*, as capable of giving a good account of herself as the 'Alexandra.' Speed is an indispensable requisite that must be secured, and, with this, the simple quality of superior handiness will compensate for inferior capacity for defence by giving increased ability for rapid manœuvring. *Commodore Simpson.*

The contest between the Peruvian light-armoured turreted vessel 'Huascar' and two heavily-armoured broadside Chilian ships of war is a strong evidence of the amount of resistance of which a lightly-armoured vessel is capable, and of the protection that is offered by comparatively light covering. The 'Huascar' was overmatched from the commencement of the fight, not on account of her lighter armour, but from the disparity in number of guns, even when contending with the first Chilian vessel which attacked her; but when she was beset by two vessels there was not the slightest chance for her. To continue the struggle against such fearful odds was heroic, but there could be but one termination to such an unequal contest.

The 'Alexandra,' which we have set up as a type, or a standard of reference, has a thickness of armour of twelve inches about her water-line; we would reduce this to six inches. The main-deck battery is protected by armour eight inches thick; we would reduce this to five inches. The upper battery is protected by six inches of armour; reduce this to four inches. The thickness of the armour bulkhead for the protection of the machinery, magazines, etc., is five inches; this might be reduced to three inches. This reduction in weight of armour, which might reach to about one thousand tons, would admit of great modification in the dimensions of the vessel.

At present the weight of the guns in the battery of the 'Alexandra' amounts to five hundred and fifteen thousand two hundred pounds, and her tonnage is six thousand and fifty tons. This gives her a ratio of weight of battery to tonnage of eighty-five pounds to one ton, which is far inside the ratio established at the Navy Department. If the changes proposed in the dimensions of the vessel should result in a reduction of one thousand tons in her tonnage, the present weight of battery would give the new ship a ratio of one hundred and two pounds of gun to one ton of ship, and this is well inside of what we consider a proper proportion to be retained between these factors. The new ship will thus be more appropriately armed, and she will be handier in every way.

I submit this idea, then, to the criticism of the Navy.

United Service.

United Service. — April 1880. 'Naval Reorganisation,' by a Junior Officer.

There is but one argument in favour of large ironclads, and that is, that should we construct half-a-dozen they would be of service as flag-ships on stations where show and appearance assist to maintain the dignity of the nation. I think the same end can be obtained by large composite ships, with heavy rifled batteries.

I take it for granted that the contest of armour *versus* guns has been decided in favour of the latter. If it is true that a gun can be built which can pierce the greatest amount of armour it is possible to put on a sea-going vessel, then let us lay aside armour, and instead of spending millions to compete with Europe in ironclads, spend as many thousands in a plant and in building enormous rifled breech-loading guns. If the projectile is going through your vessel, it is surely better to have one with great floating ability than one like the present ironclads of Europe, with great sinking facility.

I should therefore say, let us spend our money and exert our energies in establishing a plant and building guns able to pierce any ironclad afloat. . . .

First, we need a class of gunboats to 'fight bows-on,' carrying one gun of the largest size on the bows. This gun, on a vessel of eight hundred tons, would be able to fire accurately, its excellence of platform resulting from putting the gun in the line about which the vessel rolls; pitching would then be the only motion to interfere with accurate fire.

The gun should be on a fixed platform trained by the helm. A very few men would thus be able to handle it. These gunboats should also have a ram to strike well below the surface, and they should be armoured on the bows with, say, five inches of compound armour-plate.

The angle of this armour would cause it to protect the vessel from the heaviest projectiles fired from directly ahead. They should also be fitted with torpedo-spars running out by steam under water, one ahead, say thirty feet, and one on each side, say for twenty feet.

Of course, good speed is very desirable in such vessels, but those built by Sir William Armstrong and Co. for the Chinese Government, of 440 tons displacement, carrying one 35-ton gun, and fitted with twin-screws, obtain a speed of but ten knots ahead and nine astern. That we can obtain a better speed with the Mallory propeller in such small boats seems probable.

We much need a propeller with the steering facility of the old

Fowler wheel and the speed of the ordinary propeller. The report of the Board of which Chief Engineer Isherwood was president, made some months since to the Department, would indicate that the Mallory propeller possesses both the speed and steering power required to enable gunboats to fight bows-on at all times, and thus obtain invulnerability not from the thickness of armour, but from the acute angle formed by the bows. Besides, the Mallory propeller gives that great steering facility needed to properly and accurately fire the gun and to keep the vessel always bows-on, so that her armour may protect the whole hull, and also that accuracy of steering which alone enables the spar-torpedo to be successfully used. United Service.

These gunboats would be a most excellent auxiliary for our coast and harbour defence, as, owing to their small draught, they could run into shallow water, and thus elude a large vessel like the English ironclads, and then at night or at other suitable time run out and strike a fatal blow.

When engaged in large numbers together, they should manœuvre as regiments do in order to protect their rear and flanks. These vessels during peace-times would be able to do police duty, both at home and abroad, in all lakes and inland seas. The cost of the construction of these boats would be about one-tenth that of the large ironclads of Europe, and one-tenth of the number of officers and men would be able to fight them. But as each would carry one gun they would have collectively an effective battery of double the size of an ironclad, and in addition each would have a ram and torpedo-spar.

Then we need a large class of vessels, built on the composite plan, for sea-going cruisers.

These should have twin-screws, for while twin-screws are objectionable on small vessels, on account of more room being required and more steam and more machinery, requiring of course more men, in large vessels they probably are best. In large vessels with plenty of engine-room and plenty of ability to carry the increased weight, they have some advantages; while a vessel can turn just as quickly with a single screw as with twin-screws, it requires more sea-room. This is often important. A vessel with twin-screws can turn almost in the spot she lies. This enables her to get pointed for ramming, and enables her to avoid ramming better. Then, if one pair of engines is disabled she has the other propeller to rely upon.

The experience in England of late years has led to almost exclusive use of twin-screws in vessels of considerable draught.

The engines and boilers should be placed well below the water-

United Service. line, which the size of the vessel would allow, and they should also be protected by the coal in the bunkers, and, if necessary, by armour immediately about the most exposed portions.

They should also carry light spars, for sailing when lying off a coast or when making passage from place to place.

Army and Navy Journal, New York.

Army and Navy Journal. New York. July 1, 1876.

It is questionable whether the immense, cumbersome, and expensive sea-going ironclads, such as the English have recently constructed, are desirable for us, and it is very difficult to determine what a modern line-of-battle ship should be. We have not, and never have had, what is termed a line of battle; that is, a sufficient number of first-class fighting ships to oppose a fleet of first-class fighting ships of any one of the great naval Powers. The necessity for such a fleet may never arise. Our light cruisers bear a similar relation to the naval line of battle that the scouts of an army do to troops in line of battle. In regard to the construction of such vessels, upon one point all modern authorities agree, in asserting most emphatically that high speed is an essential requisite. It is demonstrable, that where there is even great disparity in all other respects, marked superiority in speed, and a longer range of fire, will render a gunboat a most formidable antagonist to the heaviest ship that floats. It is easy to see how a superb frigate, with 700 men and 50 smoothbore guns, may be destroyed by a single gun of long range, worked by a handful of men, on the deck of a small but very fast vessel. All writers are equally emphatic in urging the necessity of ramming: that is, of making fast ships, themselves, most powerful instruments of destruction, when impelled by full force against their adversary. What is called a 'complete circle of fire' is now considered essential to a high degree of efficiency. The use of rifled ordnance, of breechloading rifled guns, has been, too, urgently recommended by our highest authority, the Chief of the Bureau of Ordnance, whose recommendation has met with the earnest endorsement of the Secretary of the Navy.

November 10, 1877.

There are not wanting in every age multitudes of generalizers who reason from isolated facts towards conclusions which are contradicted by subsequent events. In warfare, and in naval warfare especially, such conclusions are more common than in almost any

other science. The art of fighting at sea is very ancient, but its principles have always been substantially the same. Pluck and skill, the fighting spirit and the capacity for surprising an opponent by unsuspected movements, are the essentials to success in naval warfare. Skill without pluck, and pluck without skill are alike insufficient. Instances in proof of this assertion meet us in the earliest naval wars and are continued in a regular series of events down to the present day. *Army and Navy Journal.*

The first sea fights of importance which meet us in history after the battle of Salamis are those of the First and Second Punic Wars. These wars found the Carthaginians—then the first naval nation of the civilized world—pitted against the Romans, the best fighting nation of antiquity. Up to the period of the First Punic War, the Romans were not sailors, but they were brimful of courage, and their skill in terrestrial warfare was superior to that of any nation then in existence; the Carthaginians were excellent sailors and skilful in fleet tactics, but deficient in courage. Their natural pursuit was commerce; and commercial nations are always timid in proportion to their wealth. The Romans were agriculturists and warriors. The course of the First Punic War was simple. The Romans built a fleet, put to sea and fought the Carthaginians, encountering a severe defeat, owing to their ignorance of tactics. Nowise daunted, the Romans built a second fleet, and learned from their first defeat how to conquer the Carthaginians. Having no chance with their active adversaries in the use of the ram, which required handy vessels and well-trained crews, they introduced close action and boarding tactics, from both of which the wily Carthaginians shrunk in dismay. As a natural consequence of their superior pluck and the skill which introduced a new method of fighting, they swept the Carthaginians from the seas, and Rome became the undisputed mistress of the Mediterranean, a position which she held for nearly ten centuries thereafter.

The next naval wars of importance which meet us in history are those of Julius Cæsar against the Gauls in the British Channel, and the wars of the second Triumvirate which culminated in the battle of Actium. In the first of these the Romans had skill and pluck combined to give them an easy victory over the clumsy valour of the Gauls. Cæsar, fighting in swift-rowing vessels which could pull into the wind's eye if required, and using both ramming and boarding tactics, easily vanquished the Gauls, who fought under sail alone in slow bluff-bowed vessels. In the battle of Actium the event was decided by the cowardice of Cleopatra and the insane folly of

Army and Navy Journal.

Mark Antony, who abandoned a battle already nearly won, to follow his mistress in her shameful flight.

The whole course of the naval warfare of antiquity in these and other battles, is in favour of medium-sized active vessels, commanded by daring and energetic officers, as offering superior chances of victory to those pertaining to either inordinately large or very small vessels. They also show that the chances of success in naval warfare are generally in exact proportion to the dash and daring of Admirals and Captains. These lessons have remained true for all time, as also the lesson that the nation which seeks the closest action as a habit is most likely to win naval battles.

The next development of naval warfare is that offered by the present conquering race of the world—the Norsemen—who under the erroneous title of 'Anglo-Saxons,' to-day girdle the earth with the possessions of their descendants. The Norse Vikings, in their swift ships, chiefly propelled by sails and using oars only as a secondary motor, ravaged all the coasts of Europe with impunity, extended their voyages to America, conquered every foe with whom they came in contact, and developed the second great period of naval warfare, which lasted virtually unchanged to the commencement of the present century. The introduction of artillery in the fifteenth century, and the gradual increase in the size of vessels, did not materially alter the condition of warfare. With the substitution of sails for oars as a motive power, the same maxims remain true which prevailed in the days of the Roman trireme. The victory still pertained as a general thing to the nation possessing the bravest and most dashing sailors, and those seeking the closest action, while the skill which introduced a new mode of offence unexpected by an adversary was sure to meet its reward until conditions were again equalised. The long series of wars between England and Spain in the Spanish Main, the destruction of the Spanish Armada in the English Channel, the exploits of the buccaneers on the coasts of Spanish America, and the long series of British naval victories over the French, from the days of Benbow to those of Nelson, were all those of medium-sized and handy ships commanded by men of great daring, generally gained against larger and more unwieldy antagonists. . . .

The forty years' peace which followed the battle of Waterloo and the universal introduction of steam navigation were thought by some to have changed the conditions of naval warfare to such an extent as to render previous experience unreliable. The Crimean War showed this to be a fallacy. Naval actions were intensified, but did not

differ materially in character from those fought in the war of 1812. Army and Navy Journal.
The conditions were equalised and that was all. The Russians destroyed the Turkish fleet at Sinope in about the same time—ship for ship—as that in which the 'Constitution' destroyed the 'Guerrière' and 'Java,' respectively, or the 'United States' dismantled the 'Macedonian.' The ships remained the same with the addition of steam power, and the guns were out of proportion to the possible defence against their missiles. The English and French fleets, had they met the Russians, would doubtless have destroyed the latter in the same manner as the Russians annihilated the Turks. As it was, the Allied fleets were wasted against fortifications, and Louis Napoleon introduced the first ironclads, in his floating batteries, for the siege of Sebastopol.

The melancholy disaster in the English Channel, last week, June 8, 1878.
should not pass without pointing a moral in regard to naval construction. The three German war ships, the 'Koenig Wilhelm,' 'Preussen,' and 'Grosser Kurfürst,' were all fine specimens of modern ironclads, the former being a broadside frigate, pierced for 26 guns, and the two latter low-freeboard, turreted ships, of the 'Monarch' model. Sifting the somewhat conflicting accounts, and cancelling doubtful factors, we find that some miles off Folkestone the 'Koenig Wilhelm' suddenly changed her course to avoid a Norwegian barque which was crossing her bows; the 'Grosser Kurfürst' did the same; but before the manœuvre could be successfully completed the 'Koenig Wilhelm' struck the 'Grosser Kurfürst' and almost instantly sank her, while her own forward compartment filled with water. Despite rapid assistance, only 217 (according to late accounts), out of a company probably numbering more than 500 on the 'Grosser Kurfürst,' were saved.

What we note first is that this accident happened in broad day, with a smooth sea, and a light breeze blowing, the sky being clear and free from mist, and the sun shining. There may have been mismanagement, that is, bad seamanship, on the part of one or the other of the vessels colliding, or of both; as bad seamanship, resulting usually from carelessness or over confidence, instead of want of knowledge, is sometimes known even to our own and the English Navy, there would be nothing surprising in finding it on these German war vessels. But thus far no bad seamanship is proved, and the probabilities point rather to an inability to

Army and Navy Journal. manœuvre these splendid vessels with the proper and necessary rapidity. The 'Koenig Wilhelm' and 'Grosser Kurfürst' were presumably nearer together than was needful; but they were not nearer than is often needful in battle.

This accident, then, carries no little suggestiveness as to the true principles of naval construction in the future. It shows, to begin with, that nothing is gained, and in fact much is jeoparded, by sacrificing mobility to impenetrability. When the contest between guns and targets first broke out, for a long time the latter held their own with great success. This was due to the invention of the American monitor by the distinguished engineer, Captain Ericsson. By his system, armour could be concentrated, absolutely impregnable not only to any existing guns then afloat, but to guns of far greater calibre than were then afloat. In time, however, the aggressive began to creep up to an equality with the defensive, and at length surpassed it. Ordnance of a size and destructiveness not dreamed of twenty years ago is now constructed, and thicker and thicker armour has been added to ships to keep the shot out. Our belief is that, in the intensity of this rivalry, even more important considerations have been sacrificed to that of invulnerability.

We can understand, too, why this mistake should be made. The ironclad is nothing, if not reasonably impervious. If her sides are as easily perforable by shot as cardboard is punctured by pins, better have no armour; because the wooden ship, also perforable, can at least run away from a too powerful enemy, or, when all is lost, can strike her colours in season to save the remnant of her crew. But the ironclad, when once pierced, is often an iron coffin; whether a rock, or a ram, or a torpedo strikes her, down she goes with astounding rapidity. Hence, we say, impregnability against well-known guns carried in foreign navies is the aim of every service. But it has become a fair question whether it is not now time to cry a halt in this sacrifice of everything to stout armour. It seems to us that a process something like that which went on in land warfare with the invention of gunpowder, is now called for in naval warfare, with the introduction of the enormous ordnance of modern times. While lances, arrows, and battle-axes were the weapons of aggression, the knight armed himself with thick armour of steel; when the bullet came so much more swiftly than the arrow, and the cannon ball more terribly than the mace, it would naturally be supposed that the armour would have been increased in thickness. But in fact from that moment it was diminished, until at length it was abandoned altogether. The explanation is that the knight had

already clothed himself as heavily as he and his horse could stand, and this was not enough. Hence the only thing to do was to at least secure greater alertness and mobility by abandoning armour altogether. *Army and Navy Journal.*

Now, we do not, of course, argue for going back to wooden war vessels; that would be preposterous. But we are convinced that henceforth, instead of trying to build enormous, unwieldy craft, whose only merit is to be thickness of armour, greater attention must be paid to speed and mobility. We concede that there is a place for even the heaviest attainable ironclads, namely, in harbours and along coasts, where they are to act chiefly as floating forts, with enough steam power to move them to any required point. But the cruising element of the Navy must be of a different character; and even if, with extraordinary speed and facility of manœuvre, the cruisers of the future cannot keep out all modern shot, they will have no worse fate than the wooden navies of times gone by.

There is a second warning and lesson in the Folkestone catastrophe, which only confirms what we have already said, and also develops it one step further. The 'Koenig Wilhelm' sank the 'Grosser Kurfürst' not by a cannon shot, but by acting as a ram. It is clear, then, that if, with all efforts to avoid an impending collision, the result of ramming this great ironclad was instantaneous ruin, the same feat can be performed with equal ease intentionally in battle. It thus becomes evident, first, that thickness of armour only provides against one of the dangers to which a war-ship is liable, and the one which is steadily decreasing in relative importance—namely, attack by guns; and secondly, that the ram must hereafter play an important part in naval warfare. It would be easy to show from historic examples the importance of the ram as an appliance of aggression; but it is enough to say that almost every fatal collision between ships is itself an argument. In the case of ironclads this logic of experience is all the stronger, because almost invariably where they have been struck by another vessel, or blown up by a torpedo, they have instantly gone to the bottom.

Our ships of war must be either destined for a specific service, like the ram or the torpedo-boat, or else, if designed for general service, must be a compromise between different aims and needs. Commodore Parker, in his history of the battle of Mobile Bay, from which we quote elsewhere, tells the story of one famous episode thus: 'As the "Hartford" and "Metacomet" were slowly passing the "Brooklyn," her captain reported "a heavy line of torpedoes across the channel." "Damn the torpedoes," was the emphatic reply of

Army and Navy Journal. Farragut. "Jouett, full speed! Four bells, Captain Drayton!"' So across the torpedoes the flagship went. Admiral Farragut told us the same story in a little different language. He said, as nearly as we remember, that when the alarm of torpedoes was sounded, he could not help saying, 'Torpedoes! why they're all torpedoes! Those guns in the forts are torpedoes. We're here to fight torpedoes! Go ahead!' The war-ships must evidently be built with a view to all contingencies. Of what use is it for some of the finest ironclads to carry enormously thick armour down to the water-line, when below it they are vulnerable to an ordinary torpedo? Of what use is armour, if there is not quickness enough to avoid the attack of the ram?

September 28, 1878. A more general reflection, suggested by the communication of Chief Engineer King, is that the triumphs lately achieved by guns should make us less anxious to build prodigious and prodigiously armoured ships. When a new chambered British gun, weighing less than four tons, is found to have a penetrative power greater than that of the existing unchambered nine-ton guns, and only a little short of the existing unchambered twelve-ton guns, it is clear that the time for piling up armour on ships, with the guarantee that it will keep out all possible shots, is over. Existing guns were already a match for existing armour, and now the former are suddenly more than doubled and nearly trebled in power, weight for weight. This gain is obviously far greater than the gain to armour we have already conceded, under not wholly conclusive trials. Obviously, therefore, we need be less disturbed at having no impregnable ships, since even the 'Dandolos' and 'Inflexibles' are no longer so. We do not mean to say that our Navy is at all what it ought to be in point of armour—it could hardly be worse off. But in the new construction which cannot long be delayed, we may be satisfied to produce several vessels of moderate size and moderate armour instead of a single costly monster, whose iron hide, as is now seen, would not be impenetrable after all. Thus these new experiments are arguments for what should be, as we have steadily maintained, the American policy in new construction.

The Naval Prize Essay, May 14, 1881. The Naval Institute prize for 1881, consisting of $100, a gold medal, and a life membership of the Institute, for the best essay on 'The Types of Armoured Vessels and Unarmoured Cruisers best adapted to the Needs of the United States,' has been awarded to Lieut. Edward W. Very, U. S. Navy. The judges of the award were

Army and Navy Journal. rights; 4th, to aid in obtaining a correct knowledge of the waters and coasts of the world by means of exploring and surveying expeditions, and to aid and extend the interests of commerce.'

These various circumstances are presented in the essay at length, and from an analysis of them the conclusion is drawn that for our 'Standing Navy in time of peace or neutrality an active force of unarmoured vessels is necessary, proportioned in number to the amount of interests at home and abroad requiring protection. Cruising stations for squadrons are necessary in those parts of the world affected by United States commercial intercourse. Vessels of a medium class are mainly required, and these vessels must possess a maximum of speed and capacity for fuel; they must also be provided with full sail-powers, not only as a matter of cruising economy but to enable them to keep the sea for long-continued periods. On certain stations these medium vessels must be supplemented by cruisers of the heavier classes. Finally, the Navy must possess a certain passive force of the stronger or armoured element.'

The sea-going or cruising types of armoured vessels are condemned, so far as the United States is concerned, we being subject to none of the necessities which compel their use abroad. Considering, then, the problem as to how a given amount of armoured strength as a mass shall be distributed in order to best defend the coast from threatened or actual attack, Lieut. Very calls attention to the fact that our coast is divided naturally into a series of districts or basins within whose limits intercommunication is readily obtained, but which are so separated from each other as to render it difficult to send vessels rapidly from a point in one to any threatened point in another. These basins may be arbitrarily named as follows: '1st, the Gulf of Maine, limited on one side by the New Brunswick boundary, and on the other by the outlying islands and banks off Cape Cod; 2nd, the North Atlantic, comprising the great bight between Narragansett Bay and Cape Hatteras; 3rd, the South-eastern or Carolina, including the crescent between Hatteras and Key West; 4th, the Gulf, from Florida Keys to the Rio Grande; 5th, the California, from San Diego to Cape Mendocino; 6th, the North-western, from Mendocino to Vancouver. The Alaska coast is omitted from consideration owing to its present lack of commercial importance.'

The types of armoured vessels should, therefore, be limited to coast-defence vessels; and owing to the limitation of total requisite strength brought about by the normal peaceful condition of the country, this power, in the interests of economy, should be divided

principally amongst light harbour-defence vessels able to support heavy guns and armour on account of the services required in beating off armed cruisers, and possessing a fair modicum of sea-going power. These qualities are best combined in the monitor type of vessels. For the armament of these monitors two long ten-inch steel breech-loading rifles are proposed, that is, guns capable of piercing a fourteen-inch wrought-iron plate at 500 yards. A comparison of weight with the present armament of fifteen-inch guns shows a decrease of two tons. The armoured vessels are modifications and improvements of the present pure monitor type. For the first or heaviest class, he proposes the 'Belleisle' type of British coast-defence vessels (reduced 'Dreadnought'), pure and simple, with a maximum displacement of 4,000 tons, double turrets and 12-inch steel breech-loading rifles. For the second class, he takes the 'Passaic' type of single turretted monitors as a base, cuts down the small freeboard, now given, to nothing, bringing the armoured deck flush with the water-line. Upon this he erects an unarmoured superstructure six feet in height all around, raising the turret that height to gain an increased command, whilst by transferring the quarters from below to the superstructure he gains space for coal and increased boiler and engine space. The manner of mounting the turret is altered to the French style; the hull is built of iron, the armour is compound steel and iron, and the battery is changed to 10-inch breech-loading rifles with a penetrating power of 14 inches of wrought iron at 800 yards. These alterations are made without carrying the displacement above 2,000 tons or increasing the draught beyond 18 feet. The armoured fleet consists of 24 vessels with an aggregate displacement of about one-third more than is now represented by our monitors. His second-class monitor resembles closely the 'Guinea' class of Dutch coast-defence vessels, which have given perfect satisfaction during the ten years that they have been in service. The table on next page shows the proposed peace strength and its distribution.

Army and Navy Journal.

'None of the old ironclads,' says the essay, 'can be economically rebuilt to meet the requirements demanded, but while these vessels still retain a semblance of strength a wise system of construction will enable the substitution to be made quietly, certainly, and without any appreciable increase in the yearly amount appropriated for constructional purposes.'

Fifty vessels is the cadre proposed for the unarmoured vessels of the Navy List, and to provide a margin for non-effectives it is proposed to have at least sixty vessels off the stocks in order to realise this force of fifty vessels available within six months. His 1st rate

Army and Navy Journal.

Name of Basin	Needs of the Basins for Armoured Vessels	Armoured strength detailed			
		No. of Vessels	Total Displacement	Per Cent. of Total Force	Artillery Power
			Tons		
North Western and California	To secure California coast ports from attack in case of war with Chili or Japan by having at each threatened point a vessel able to contend with the enemy. In case of war with Great Britain, to seriously menace the safety of Vancouver, and to present a force sufficiently strong to cope with British unarmoured strength in the Pacific	3	10,400	16½	Eight 12-inch, and two 10-inch B.L. rifles
Gulf	To assume offensive operations speedily against Cuba in case of war with Spain. In a war with Great Britain or France to protect the naval stations of Pensacola and Key West, and prevent the enemy from seizing and holding the Florida Keys	5	10,000	15¾	Ten 10-inch B.L. rifles
Carolina	To protect Charleston and Port Royal from the raids of armoured vessels, and to reinforce the vessels detailed for the protection of the Florida Keys, or the blockade of Cuba	2	4,000	6¼	Four 10-inch B.L. rifles
North Atlantic	To prevent the enemy from seizing and holding Nantucket, to protect the naval establishments of Newport, New London, New York, Philadelphia, Norfolk, and Washington; to secure the safety of the commercial metropolis of the country; and to prevent armoured cruisers from patrolling the most important basin of the whole coast	10	28,800	45¼	Sixteen 12-inch, and twelve 10-inch B.L. rifles
Gulf of Maine	To protect the naval station of Portsmouth; to prevent raids by armoured vessels into the partially isolated but important basin; to aid in the defence of Nantucket, and, in case of war with Great Britain or France, to force the maintenance of a strong naval power at Halifax or St. Pierre and Miquelon	4	10,200	16	Four 12-inch, and four 10-inch B.L. rifles
	Total peace strength	24	63,400	—	28 12-in. 32 10-in.

Displacement tonnage of the existing armoured strength . . .	52,360
" " armoured strength on the Pacific Ocean .	3,500

unarmoured vessel is of the 'Trenton' class, with a change of battery from eleven 8-inch rifles to sixteen 7-inch; the position of the spar deck is altered so as to give an increased power of fore-and-aft fire, and the steering-wheel and bridge are mounted forward of the foremast. The 2nd rate is of the 'Alaska' class with a lengthened forecastle, a broadside battery of 6½-inch rifles and two 8-inch pivots and an improved arrangement at the break of the poop, by which, without interfering in the least with the cabin, a clear stern and quarter fire is attained from two 6½-inch guns. The 3rd rate is of the 'Swatara' class, and the 4th rate of the 'Yantic,' the battery arrangements being somewhat similar to that of the 2nd rate. He recommends an iron hull sheathed for 1st rates, a steel hull for 2nd rates, and composite for the 3rd and 4th. He presents this tabulated statement of the fleet, showing a total of sixty unarmoured vessels with an aggregate displacement of but a little over 700 tons more than is now represented by our ships afloat: *Army and Navy Journal.*

Class	No. of Vessels	Limits of Displacement	Aggregate Tonnage	Battery
		Tons		
First	8	3,800 to 4,000	31,200	16 7-inch long B.L. rifles
Second	12	2,200 to 2,400	27,600	2 8-inch " " 8 6½-inch " " 3 60-pdr. " "
Third	24	1,300 to 1,500	33,600	4 6½-inch " " 4 60-pdr. " "
Fourth	16	900 to 1,100	16,000	2 7-inch " " 4 60-pdr. " "
Total	60		108,400	

GERMAN AUTHORITIES.

Admiral von Littrow and Captain von Brommy.

Admiral von Littrow and Captain von Brommy. — *Die Marine*, Vienna, 1878, p. 862.

WE have already stated that the two Italian turret ships are to be armed with four 100-ton guns. But we have by no means reached the furthest range of artillery development. In the gun foundry at Woolwich, where the 80-ton gun is scarcely completed, plans are under discussion for a gun weighing 160 tons, and capable of firing a projectile weighing 1,500 kilos., or in English weight approximately about one ton and a half. The 'Inflexible' is built to receive an armament of 160-ton guns. The armour which was insufficient to resist the force of the 100-ton guns will obviously be insufficient to keep out the projectiles of the 160-ton gun at a still longer range. The penetrating power of each 1,500-kilo. (1½-ton) projectile is equal to 90 metrical tons for each centimetre in the circumference of the projectile. If then armour is wanted capable of resisting such a monster projectile, the thickness must be increased to one metre, or 40 inches, which will give a power of resistance per centimetre of circumference of the shot equal to nearly 95 metrical tons.

The dimensions of a ship capable of carrying four 160-ton guns and armour one metre, or 40 inches, in thickness must be as follows:—Displacement, 20,603 tons; length, 126 m., or 416 feet; breadth, 25·50 m., or 84 feet; depth, 10·98 m., or 36 feet; area of the immersed midship section, 226·614 □ m., or 25·20 feet; engines, 16,000 I.H.P.; speed, sixteen knots; coal supply at full speed for 1,600 miles, at twelve knots for 3,500 miles. The weights will be distributed as follows:—Hull, 7,240 tons, or 36 per cent.; armament, 1,400 tons (7 per cent.); machinery, 2,400 tons (11 per cent.); coal supply, 1,920 tons (9·3 per cent.); armour, 6,840 tons (33 per cent.); ground tackle, 620 tons (3 per cent.).

We may compare with these data the corresponding figures for the fourteen-knot ship 'Inflexible,' namely, hull, 4,100 tons; armament,

700 tons; machinery and coal, 2,400 tons; armour, 3,600 tons; equipment, 500 tons; total 11,300 tons. The cost for the former ship would be 23,500,000 francs, or a round sum of 9½ millions of gulden—940,000*l.* *Admiral von Littrow and Captain von Brommy.*

Are we to contemplate the construction of ships of such colossal proportions? The future will reveal whether we shall continue to add to the weight of armour, or whether we shall resolve on a new policy. The numerous powerful ironclads at present in existence in the fleet will still most certainly be capable of service. And if they are not a match for the new ironclads, their inferiority will not be greater than that of the wooden ships to the first ironclads. The question must however be considered whether we are to throw off armour altogether when absolute protection becomes impracticable. If armour is abandoned, we have at least some reason to hope that, when the sides of ships offer but a slight resistance, shell from heavy guns will pass through without exploding, while it is certain that the projectiles will penetrate the heaviest plates and explode. When penetrated, the fragments of the ship's side will be driven forward with the fragments of the shell, and increase the work of destruction.

The question is further complicated by the introduction of a new weapon into naval warfare, which is likely to work as complete a revolution in tactics as steam, heavy guns, armour and the ram; we refer to the torpedo. We have now no longer to deal with the stationary torpedo alone, which bars the entrance to harbours, which is carried by the current until it comes into contact with the enemy, or is fired by an electric apparatus. The torpedo has become an offensive weapon. Daring self-sacrificing men are no longer needed, as in the War of the Secession, to dash the torpedo against the side of the enemy's ship. Properly armed and adjusted, it can be fired from a distance at the mark. It can be discharged from the side of the ship, and thus solves the problem of a submarine gun. Unseen by the enemy and without imperilling the ship from which it is discharged, it will accomplish its work, while a duel between rams is likely to prove equally fatal to both combatants. What protection does armour afford against this new weapon? And for that armour how many qualities have been sacrificed? The cost alone has been so increased, that for every two ships only one can now be brought into line of battle. It seems reasonable to infer, in view of these considerations, that at no distant day armour will be removed from the sides of battle-ships.

The conditions of naval warfare are so conflicting that it is difficult

Admiral von Littrow and Captain von Brommy.

to determine which of the maritime Powers is on the right path. The special qualities of each type are obtained to the detriment and exclusion of other qualities. In one case strength is sacrificed to speed and handiness. In another, speed is subordinated to armour protection and armament.

The superiority of one navy to another is an ephemeral and, so to speak, momentary advantage. It depends on the points of view from which the comparison is made. The guns will always be superior to the armour. The most strongly armoured ships are not secure from destruction. How many circumstances will operate in deciding the issue of a long naval war? How will the floating fortresses behave in tempestuous weather? And what shall prevent a ship, having a superiority of speed, from choosing a distance at which it will be beyond the reach of a more heavily armoured, but helpless enemy?

This at least is true, that the risks of naval warfare are becoming more and more terrible, and that the expenditure on individual ships is augmenting by leaps and bounds. A ship could formerly be built for from one and a half to two millions of gulden, or from 150,000*l.* to 200,000*l.* The cost of an ironclad has advanced from 350,000*l.* to 400,000*l.* as it was in 1869, to from 600,000*l.* to 650,000*l.* at the present day. We have not yet reached the culminating point of this expenditure, and yet a single torpedo can sink this extravagant structure beneath the waves.

When the warriors of the sixteenth century saw that their armour was useless against firearms, they laid it aside, and bared their bosoms to the foe. So in the navy the age of armour is drawing to a close. It will be more politic, both for attack and defence, to increase the number of smaller ships of a light and handy type; and yet it is but natural that every nation should hesitate to assume the responsibility of leading the way in this direction. Certain it is, this increase which has lately been taking place in the dimensions both of ships and guns must be drawing near its term, and it cannot be doubted that the time is not far distant when we shall take a new departure in our shipbuilding policy.

. . . . .

To resist the new monster guns, recourse must be had to a thickness of armour which was formerly held to be impracticable, and thus we are led inevitably to a displacement of more than 10,000 tons. In the year 1873 the English 600-pounder was the heaviest gun afloat, and the naval constructors considered a plate of 31 c/m. or 17 inches was sufficient. In 1875 the 81-ton gun issued from the

English gun factory. In 1876 the 100-ton gun was produced, and now a 200-ton gun is under consideration. *Admiral von Littrow and Captain von Brommy.*

As the guns become more formidable, so the armour must be increased in thickness. From 1851 to 1868 an increase in the thickness of armour of three inches was required. From 1868 to 1872 an increase of 8 c/m. or 2½ inches was demanded. From 1872 to 1876 an additional 1½ inches was required. A plate of 35 c/m. or 14 inches will resist a shell from the 30-ton gun, but iron plates 32 inches in thickness are required to resist the most recent guns. The new Krupp gun of 57 tons penetrates at a distance of 1,800 metres plates of 24 inches of the same iron from which the excellent plates of the English ship 'Inflexible' are manufactured.

. . . . .

The English look with great satisfaction on their latest ship, which in truth, in dimensions, fighting power, and in the perfection of its details is unrivalled, and far surpasses both the Italian breastwork monitors, 'Duilio' and 'Dandolo.' But the design for the huge 'Inflexible' exhibits a noticeable innovation in the limitation of the area protected with armour.

We cannot share in the satisfaction with which the English regard their latest monster ship.

Mastless armoured ships may be well adapted for the exigencies of naval battle, and for coast defence; it is most certain that these mechanical houses—ships we can no longer call them—will have much difficulty in escaping the thrust of the ram of an agile enemy. They draw too much water. With any disturbance of the sea every opening must be closed, and then life on board becomes intolerable. In short, mastless ironclads can only be regarded as offensive coast watchers. Beyond this sphere of action they fail to fulfil the intentions of their designers.

Pro-Memoria on the Ship-building Policy of the German Admiralty, recently distributed to the North German Parliament.

The contest between the armour which protects the battle ship and the heavy breech-loading guns, in which the victory seems always to incline more and more on the side of the gun, has led to much discussion as to whether armour affords a protection to ships of sufficient value to justify its retention, when we consider the grave objections which can be urged against armoured ships, not *Pro-Memoria.* Berlin, 1881.

Pro-Memoria.

Argument for small ironclads.

the least important of which are the enormous cost, both in the original construction and in the maintenance and repairs. It may be said, by those who object to the policy of building armoured ships, that there is nothing to justify the retention of armour, now that it is no longer impenetrable at the distances within which ships must approach one another, in order to bring an action to a decisive issue. The advocates of this view point to the recent innovations in naval warfare in confirmation of their opinion. They argue that the invention of the torpedo has placed a new weapon in the hands of seamen. The power of the gun had already been so greatly developed, that the most thickly armoured ships could be destroyed by a single well-directed shot. The torpedo has rendered it possible to attack the powerful colossus of the seas, with small vessels, with every prospect of success.

Survey of history of ironclad construction.

The inquiry as to the value of armour protection for ships of war will be materially elucidated, the object with which armour was introduced will be brought clearly into view, and the measure of success which has attended the efforts of the naval constructors to give protection by means of armour, will be best ascertained by making a brief retrospective survey of the circumstances in which armoured shipbuilding first originated, and by following up the historical development of armoured construction.

In the days of the sailing, wooden built, ships of war, armed with smooth-bore guns, their projectiles consisting almost exclusively of the cast-iron shot which, until within the last thirty years, were chiefly used in all the navies of the world, it was laid down as a fixed rule of tactics, that ships could not go into action on fairly equal terms, unless they were of approximately the same displacement, and were armed with the same number of guns. A vessel, with the armament of the olden days, was capable of enduring a heavy hammering before being compelled to retire from the engagement; and the effect of the solid shot was proportionately small on the crews, and still more on the hulls of ships.

The seven-inch guns, and in most cases it was only ships of the line which carried guns of heavier calibre on their lower deck batteries, made so small an aperture, that when the ships were penetrated below the water-line, the shot-holes were almost closed up by the elasticity of the wood, and only a limited amount of leakage ensued. In the interior of the ship there was nothing destructible, except the rudder-head, upon which the fighting capabilities materially depended. Out of these circumstances arose the necessity of carrying a large number of guns in every ship, in order to bring an

engagement to a decisive issue; and hence it was that the ships of the line could alone be reckoned as effective instruments of war. Already, however, in the beginning of the year 1850, a considerable change had taken place in this state of things through the more and more effective use of shell from smooth-bore guns. The shells caused a hitherto unheard-of havoc among the crews; and, if they penetrated the water-line, they caused dangerous leaks. The necessity for some means of protecting ships became still more urgent, now that the introduction of steam for the propulsion of ships had so much increased the complication of internal structure, and, as a necessary consequence, the vulnerability. A powerful ship might be disabled, if the machinery was struck by a single shot. Even when the machinery was lowered below the water line, and tolerably secured against a direct blow, it was still exposed to dangers not less serious from the explosion of shells, which had penetrated into the interior of the ship. *Pro-Memoria.*

With the improvements which were being introduced it was obvious that the ships were becoming incapable of much resistance to the ever-increasing power of the gun.

The fatal effects of shell fire were shown in the engagements fought during the Crimean war, and more particularly in the destruction of the Turkish fleet at Sinope, and at the bombardment of the forts of Sebastopol by the combined English and French fleets. The Russian shells in both engagements inflicted most serious injury on the ships; and the necessity for some more effectual protection against the destructive effects of projectiles of a character so formidable was proved by incontrovertible evidence. With a view to give to ships the protection, which was so urgently needed, a few armoured batteries were constructed. Crimean batteries.

For the purpose of attacking the Russian coast defences, vessels were required capable of resisting a shell from the Russian guns, and able to bear the brunt of a prolonged engagement at close quarters. The war was being actively prosecuted; and, as the short space of time available did not suffice for the construction of large ships, it was necessary to be content with small vessels, which could be built quickly.

The armoured batteries were used in the bombardment of Kinburn. The success of the experiment was beyond expectation. Not only did the shells explode harmlessly on the iron sides, but even the solid shot broke up, or bounded off the armour without inflicting any damage. The latter was a result which might have been quietly looked for, and anticipated with satisfaction; but it

Pro-Memoria. was not the primary object for which armour had been introduced. The main purpose was to protect the ships from annihilation by shell fire.

After the conclusion of the Crimean war, the new system of ship construction was rapidly developed both in France and England; and, while armour was being used to protect ships, naval architects had to include in their calculations a new and most important factor, in consequence of the general introduction of rifled guns for the armament of ships.

'Gloire.' The ships constructed on the old system had been proved to be incapable of resisting the destructive effect of the shells from smooth-bore guns, and the introduction of rifled guns made another complete revolution in naval architecture inevitable. The extraordinary increase in the powers of the gun pointed to the necessity of diminishing the target offered by these ships of the line, and which it was impossible to miss even from a considerable distance. It was scarcely conceivable that a colossus mounting 120 guns could be completely protected with armour. Some means of protection was to be sought for as against the shells from rifled guns. More than this it was deemed vain to attempt. The effect of the shells was increased in an extraordinary degree, in comparison with any results attained in the case of smooth-bore guns, by the introduction of elongated projectiles. The bursting charges were doubled and even trebled. It became practicable to fit the shells with fuzes which would secure the bursting of the projectiles in the armour belt, where a dangerous leak would be opened, and the destruction of the interior of the hull must ensue, while the splinters would cause a vast amount of injury to the crew, the machinery, the steering gear, and other parts of the ship, on which the fighting power essentially depends. Taking into consideration the conditions with which the naval constructor had to deal at the time, the first armoured battle-ship, the French ironclad 'Gloire,' which was completed with three-inch plates, was considered sufficiently protected to resist the most powerful guns which were at that time mounted on board ship. The 'Gloire' was launched at the end of 1859, and at the same time several ships of similar type were laid down.

'Warrior.' Even in England, where a strong prejudice existed against the construction of ironclads, it was impossible to resist the conviction that the ships of the French Navy possessed an offensive and defensive power far exceeding that of any ships in the English Navy. The Admiralty accordingly determined, even before the 'Gloire' had been launched, to lay down two powerful armoured ships, the 'Warrior'

and the 'Black Prince,' which were to be completed in 1860-1. They had stronger plating than the French ships, sufficiently thick indeed to resist the shells of the heaviest guns then in existence. The construction of these vessels was the death-knell of the ships of the older types, and all the naval Powers of Europe followed more or less quickly the example of France and England. Pre-Monitors.

While a brisk controversy was still carried on as to the value of armoured ships, and the necessity for introducing them into the navy, two incidents occurred which afforded conspicuous evidence of the superiority of armoured ships—we refer to the engagement in Hampton Roads between the 'Merrimac,' an armoured vessel fitted out by the Southern States, and an unarmoured squadron, and to the battle of March 8 and 9, 1862, between the 'Merrimac' and the 'Monitor,' the first ironclad introduced into the fleets of the Northerners. American Monitors.

The 'Merrimac' was originally a wooden frigate, which was sunk at the commencement of the civil war by the Unionists in Gosport, Norfolk. The vessel had been scuttled to prevent her from falling into the hands of the Southerners. She was afterwards raised and converted into an ironclad. The sides of the ship were armed with 4-inch plates, and over the deck an iron roof was constructed of approximately the same thickness, which afforded cover to the guns. The armament consisted of ten guns, 8- and 9-inch Dahlgrens, and two rifled 7½-inch guns. The guns were mounted at ports cut in the sloping roof, with which the deck was protected. The squadron in Hampton Roads consisted of four wooden frigates of the oldest type—the 'Congress,' 'St. Lawrence,' 'Minnesota,' and 'Roanoke.' The two latter were screw ships. In addition to these vessels the Northerners had a sailing corvette, the 'Cumberland.' These vessels were intended to blockade Norfolk, and to watch and detain the 'Merrimac,' the construction of which was not yet completed. On March 8, 1862, the latter steamed out from Norfolk, accompanied by two gun-boats, to attack the Unionist ships. She first attacked the 'Cumberland' and 'Congress,' which were anchored nearest to the point from which the attack was made. She fired a broadside into the former vessel, which caused great loss among the crew, and compelled them to run their ship aground. She then attacked the frigate 'Congress,' armed with fifty 8- and 10-inch guns. This vessel, in order to escape the fate of the 'Cumberland,' slipped her anchor, but was compelled to surrender after an engagement lasting about an hour, in which she had been reduced to a complete wreck, and half her crew had been either killed or wounded. The 'Merrimac' had

Pro-Memoria.

escaped almost uninjured, the projectiles of the enemy having produced no effect whatever against her armour. The 'Minnesota' and 'Roanoke' ran ashore in order to save themselves, and could only take part in the action from a distance. Towards evening the 'Merrimac' steamed back to Norfolk. Next morning she again appeared to complete the work of destruction, but in the meanwhile the situation was changed. In the night the armoured battery of the Northerners, the 'Monitor,' had arrived. She was, in truth, a mere pigmy when opposed to the 'Merrimac.' She was armed with only two 11-inch guns, but she was protected with 5-inch armour. The two adversaries measured their strength in a determined encounter, and, after an engagement lasting more than an hour, the 'Merrimac' retired seriously damaged. The sensation produced by this battle, and the influence it exercised on the construction of ships of war was enormous. A poorly armed wooden frigate had with impunity attacked a vessel, which had a tenfold superiority in armament, and destroyed her in a short time without suffering any loss. The same vessel was in turn defeated by a vessel carrying two more powerful guns protected by thicker armour than her own. It was clearly established by these events that armour and an armament of heavy guns, with projectiles of greater penetrating power, were necessary for battle ships.

All the naval Powers set to work energetically to convert their ships into ironclads; and a struggle was commenced between guns and armour, in which all the resources of technical science were enlisted, and both the art of shipbuilding and the construction of guns were brought to an unprecedented degree of perfection. It soon became evident that it was impracticable to give to ships an absolute protection by means of armour. If the thickness of armour was increased, guns of a heavier calibre and armour-piercing projectiles of a more formidable character were produced. The superiority of the gun becomes, however, much less marked under the practical conditions of a naval engagement. It is possible, as it has been shown, to penetrate the heaviest armour, but in experimental firing the targets are fixed at short distances, and receive perpendicular blows from guns, which can be laid with the utmost accuracy. These are conditions which can rarely obtain in an actual engagement. Moreover, in order to penetrate armour, solid shot will be required, or shells with such thick walls that only a small bursting charge can be introduced. Such being the case, even if the armour belt be penetrated, a comparatively small amount of damage will be inflicted.

Considerable light is thrown upon the discussion as to the value of armour, as against the modern artillery, by a careful examination of the incidents of the battle of Lissa, the only battle in which any considerable number of ironclads have been opposed to one another, and in which at the same time wooden ships have been engaged with ironclads. The lessons to be learnt are the more valuable, inasmuch as the relative power of the gun as against the plate was nearly the same as at the present day. A certain proportion of the guns used in the action were undoubtedly capable of penetrating the armour, which was exposed to their fire, while others had not a sufficient power to penetrate the armour. *Pro-Memoria.* Lissa.

The Italians had twelve ironclads, one of which should not be included, having been disabled in a previous action off the island of Lissa. To meet these ships the Austrians had seven ironclads. The armour of the ships in both fleets was nearly equal, although the Italians were rather more fully protected. While, however, the Austrians had no guns which could be relied upon to penetrate the ships of the enemy, the Italians had a considerable number of armour-piercing guns distributed through their fleet. The wooden ships on both sides were about equal in strength, but it is to be observed that the Italian wooden ships took no part in the action, while the Austrian ships went boldly into the engagement under the protection of their ironclads.

The result of the action is well known. After the loss of the armoured frigate 'Rè d'Italia,' which was sunk, and after the loss of the ironclad 'Palestro,' which was set on fire and blown up, the Italians withdrew. In investigating the circumstances which led to this result, it is necessary to consider, in the first place, the effect produced by the guns, both on the ironclads and on the wooden ships.

The Italian fleet sustained a total loss of 780 men killed and wounded. Of these, some 400 men were lost from the foundering of the 'Rè d'Italia,' and 230 from the blowing up of the 'Palestro.' Setting aside these 230 men, the loss caused by the fire of heavy guns and small arms was 110. This was a very small number, when it is considered that, without including the wooden ships which took part in the action, the complements of the ironclads alone were no less than 5,000 men. The limited loss sustained is the more remarkable, because during the two hours through which the action was protracted the ships were firing at each other at close quarters.

It is not alone in the effectual protection which the armour afforded,

Pro-Memoria.

that an explanation of the result of this battle is to be sought. It may be objected that the 'Palestro' was set on fire by the projectiles of the enemy, and in this case the armour afforded no protection. In answer to this, it may be stated that the conflagration was caused by the shells which penetrated into, and burst in the unarmoured part of the ship, and that owing to the limited experience which had been accumulated at that date in the construction of ironclads, no effort had been made to protect against the effects of fire those unarmoured parts of the ships which were not considered vital places.

The ships themselves, as might have been expected from the calibre of the Austrian guns, had sustained little injury from the projectiles, and they were quite able to continue the action.

On the other side it was to be expected that the Austrian ships, being only partially armed with armour-piercing guns, would suffer considerably in their hulls, and that there would be a great loss of men. Such was not the case. The total loss of the Austrian fleet, manned by a force of 7,000 men, was 33 killed and 124 wounded, and of these 22 were killed and 82 wounded, two-thirds of the total loss, on board the unarmoured ship of the line 'Kaiser.' The losses of the Austrian ironclads were exceedingly small. The armament of the enemy, as it has already been observed, included only a limited number of guns of sufficient power to penetrate the armour at short ranges. But few shots had penetrated the armour, and none had passed through both the armour and the backing. It is not a little remarkable that armour, which within a short range would have been easily penetrated in merely experimental firing, afforded in action an effective defence against shot of the same calibre. Nearly all the projectiles struck the sides of the ships at an angle, and consequently lost a very considerable proportion of their penetrating power.

It is important to study the disaster which befell the unarmoured line-of-battle ship 'Kaiser,' a representative of a type of battle ship regarded a few years before as a faultless model. This vessel was a large and handy ship with a powerful engine and a good armament, having two guns reckoned at that date as of heavy calibre. Immediately after the commencement of the action, she was attacked by a number of Italian ironclads. She lost through their fire a large proportion of her crew, and, as the means of self-preservation, was compelled to ram one of the enemy's ships, losing her bowsprit and foremast, and being compelled to withdraw with such serious injuries that she was completely disabled. The loss in men, if calculated as

a percentage of the total strength, was nearly 12 per cent., while in the remaining ships of the fleet the loss was not quite one per cent. The fact that the other ships of the Austrian fleet sustained but a trifling loss, is to be explained from the circumstance that, owing to their smaller size, they were more difficult to hit, and the more so, because the Italian ships, regarding them as enemies, which could not produce any decisive effect on the issue of the battle, concentrated their attack on the ironclads, and the 'Kaiser;' which latter, both from her size and as the flagship of the second in command, drew upon herself the main attack of the enemy. *Pro-Memoria.*

Another episode in the battle of Lissa supplies some further indications as to the offensive and defensive power of ironclads. The Austrian armoured frigate 'Ferdinand Max' succeeded in ramming the 'Rè d'Italia' on her broadside, and nearly at right angles. The latter ship was unskilfully handled, and was scarcely moving when the blow was struck. The result was terrible. In a few moments the wounded ship disappeared beneath the waves, while the 'Ferdinand Max' sustained only a trifling injury in the stem. Twice before the Italian ship had made an attempt to ram. On each occasion she had struck the enemy at an acute angle, and the two ships had collided without serious injury on either side.

The battle of Lissa gave a further proof of the value of armour protection, and supplied a strong impetus to the construction of ironclads at a comparatively early stage. It also showed the necessity of the system of internal construction already extensively adopted, in which the interior of the hull was subdivided into numerous compartments separated from one another by watertight bulkheads. Such a subdivision is a most effective method of avoiding a catastrophe like that which befell the 'Rè d'Italia.' In modern ships of war it has been largely developed.

General view of ironclad construction.

The constantly increasing power of heavy guns has led to a proportionate increase in the thickness of armour; and, as further demands for protection have been made from the constructor, in the endeavour to comply with them the art of shipbuilding has undergone a complete transformation. It may indeed be affirmed that it is only under water that the old forms are retained in ships of modern construction. Above the water everything is changed. Again, as it has already been shown, the struggle between guns and armour has not only led to improvements in the construction of guns, and in the manufacture of armour with greater powers of resistance, it has also raised the construction of ships and machinery to such a degree of perfection, that the development of naval archi-

Pro-Memoria. tecture to meet the requirements of modern naval warfare may be considered among the most remarkable achievements of constructive science in the present century.

The powerful engines, with the necessary coal supply, the division of the ship into numerous watertight compartments as a protection against the effects of the torpedo and the ram, the heavy guns and the thick armour, led to such a vast increase in the dimensions of the ships that it soon became necessary to abandon the attempt to give complete protection, or to accept ships of enormous dimensions and corresponding cost, for the sake of securing protection by armour, with a capability of resistance proportionate to the penetrating power of the guns. It being necessary to recognise some limitation of size, the area of protected side was gradually diminished, and it was only attempted to protect effectually the buoyancy, which was done by a belt at the water-line, the magazines, the engines, the steering gear, the guns, in short, all those parts which were essential to the fighting power of the ship. In all other places the ships were left unprotected, and it became the main object to mitigate the effects of the explosion of a shell by avoiding the use of combustible materials in the construction, and by protecting the stores against the effects of fire. It is not necessary to consider in detail the development of armour protection. The main scope of the present paper is to examine critically the value of armour, and to justify the policy of building armoured ships. It is sufficient to observe that the necessity of armour has been accepted by the principal maritime Powers, and that we find in the newest ships the vital parts protected by armour of the thickness of 24 inches.

Having reviewed the past history of ironclad construction, it is not difficult to determine with accuracy the question as to whether or not they have fulfilled the main object for which they were originally devised. Ironclads were built, because unarmoured ships were incapable of resisting the fire of the improved artillery.

Armour essential. Some means of protection had become necessary, and armour had been effective for this purpose on every occasion where it had been subjected to a fair trial. The few isolated cases in which, in spite of the armour, the enemy's guns had gained a victory over the ship, —the destruction of the 'Palestro' being a notable instance,—are not to be accepted as an argument against the ironclads. When ironclads were introduced it had never been assumed that no injury would be sustained. The real aim, as it has already been shown, was so to increase their power of resisting artillery as to prevent ships from being destroyed in a few moments under fire. By the intro-

duction of armour, ships of war are able to expose themselves to the incalculable chances of battle. Those chances may possibly go against the ironclad; for it has always happened, and always will happen, that, by a coincidence of unfavourable circumstances, the stronger may occasionally be defeated by an adversary of inferior power. *Pro-Memoria.*

Another and still more serious question remains for solution. Is it wise to continue to protect ships by means of armour when we take into view the enormous development which has been witnessed in the power of the gun, and when we consider that the means of destruction by the ram and by the torpedo have been increased in a degree never contemplated when armour was originally introduced? It may be asked whether it is not better, under all the circumstances, to cease to construct ironclads, the number of which, in consequence of their enormous cost, must always be limited, and to substitute a greater number of light unarmoured ships, which, with their armament of heavy guns, with the ram, and with an equipment of torpedoes, would possess a means of destroying the ironclads. In order to answer these inquiries, it is necessary to compare the relative efficiency of all these weapons, to examine their effect on wood-built and on iron-built ships, and to determine the power of resistance of both these classes of vessels.

Relative value of the gun, the ram, and the torpedo.

The principal naval weapon is still the gun. Rams and torpedoes must be regarded as nothing more than auxiliaries, which indeed give a most valuable support to the gun, and under special circumstances are equally destructive and produce even more decisive results. They are not, however, to be regarded as a substitute for guns, and can only be used with effect in action under special circumstances. In an engagement between ships and forts they are of necessity quite useless, and in an engagement between ships the opportunities for using them will be so few and far between, that we are obliged to regard the guns as of primary importance in the armament of the ship. Turning to the ram, it is an indisputable fact that the strongest ships, whether armoured or unarmoured, even those fitted with the most approved appliances which the science of construction has discovered, and subdivided into numerous compartments, would be disabled if rammed by an enemy on the broadside, at, or nearly at, right angles. In such a case the effect would be the same, whether the blow were given by an armoured or an unarmoured ship, since the latter has quite sufficient momentum to crush in the side of any enemy. The necessity for watertight compartments was thoroughly accepted, before the destruction of the

Pro-Memoria.

'Rè d'Italia' at Lissa, as a means of preserving buoyancy. The loss of that ship was, however, due not so much to the loss of buoyancy as to the paralysis of the motive power and steering gear from the influx of water. The decisive effect of a well-delivered blow with a ram is indeed indisputable. On the other hand it is difficult, by the use of the engine and the rudder, to penetrate the side of an adversary with an oblique blow, and the probability is so great of a small error of judgment, both as to the distance and the speed, that very few instances are on record of a successful attempt to ram an uninjured ship in action. It is when the gun and the torpedo have done their work, and deprived the enemy of his motive power or the use of the rudder, that the rams can be brought into play for the purpose of bringing the engagement to a speedy close. It has already been said that the effect of a blow from the ram is the same, whether the ship be armoured or unarmoured, but the chance of giving a blow with the ram is by no means equal for ships of both classes. The power of the guns of the present day is so terrible that the unarmoured ship would in all probability be disabled before she has closed with the enemy. If the first attempt at ramming fail, as will probably be the case, the unarmoured ship will be exposed to the full effect of the enemy's guns, and will infallibly be destroyed, while the ironclad will be effectually protected in those vital places, on the preservation of which the ability to continue the action essentially depends.

The torpedo is as ill adapted as the ram to be substituted for the gun as the chief weapon for a ship of war. For coast and harbour defence, for the purpose of forcing a way through a blockading squadron, or for harassing and annoying ships employed in keeping up the blockade, and even for making an attack on an enemy's ship in the vicinity of his own ports, the torpedo is eminently serviceable and indeed indispensable. On the other hand, its value is greatly reduced in a regular action between war ships, and in all cases it is not to be compared in effective power with the gun. Moreover, the range of the torpedo is limited; and, when directed against ships steaming at high speeds, accuracy of aim is impracticable. Torpedoes will exercise a great influence on naval warfare, and on the tactical movements of fleets. The torpedo will make it necessary to use extreme caution in the attempt to ram. Commanders will take care not to fight an action at close quarters. But, as compared with the gun, the torpedo will play a distinctly subordinate part. In the present day, as in the past, it is by the gun that victories will be gained at sea. Ships must be designed

mainly with the view to develop the power of the gun to the best advantage. The ram and the torpedo must be ranked as of minor importance. When we come to examine the various questions relating to the building and the armament of ships, we cannot but recognise that it is indispensably necessary to give protection to those parts on which the life of the ship depends; and, as no other plan has yet been discovered, armour must be retained. The guns of the newest ships have a calibre of 34 c/m., or 13·38 inches, and they fire projectiles weighing 400 kilogrammes. The introduction of such guns into naval armaments can as yet be regarded only in the light of a tentative and doubtful experiment. Their enormous weight makes it difficult to work them, and their fire is so slow that it is very doubtful whether a larger number of light but still powerful guns would not be more advantageous. In any calculations on this subject it must be assumed that in ships of the latest construction we shall have to deal with guns of a calibre of from 26 to 32 c/m., or 10·37 to 12·59 inches, firing projectiles of from 200 to 400 kilogrammes, or 440 to 880 lbs. A great variety of projectiles may be used according to the type of ship with which the engagement may be fought. If it is necessary to penetrate thick plating, either solid shot must be used, or shells with such thick walls that they will not break up as they pass through the armour. The bursting charge of shells of this description must be small. On the other hand, in firing at unarmoured ships or similar objects, projectiles are used of a less solid character; these are called common shells. They have walls of no great thickness, but sufficiently strong to bear the strain of the powder gases in the gun. In these cases heavy bursting charges are used, amounting in some cases to 20 kilogrammes, or 44 lbs. *Pro-Memoria.*

It is not difficult to realise the destructive effects produced by such a projectile penetrating an unarmoured ship, fitted with a fuse, which will cause an explosion at the instant when the ship's side is penetrated. If it strikes near the water-line, it will cause a leak, which will either sink the ship; or, if provision has been made by means of watertight compartments for such a contingency, it may possibly disable the ship. If it strikes in wake of the batteries, the result will be scarcely less serious; the iron splinters of the projectile, and the fragments, torn away from the ship's side, and hurled with fearful violence into the interior, will cause enormous loss among the crew. The gun carriages, and probably the machinery and other fittings essential to the safety of the ship, will be destroyed. The unarmoured ship had already been proved to be incapable of enduring a long-sustained

Pro-Memoria.

action against the light guns formerly in use; and, when we take into view the increased power of the guns of the present day, it is still less likely that unarmoured ships will be able to fight an engagement with success. A single shot would seriously disable them.

'Shah' and 'Huascar.'

The only occasion, in recent years, in which armoured and unarmoured ships have been engaged, displayed for the first time in a striking manner the absolute inferiority of an unarmoured ship as against an enemy protected only with thin armour. In the year 1877 a revolution broke out in Peru, and the party opposed to the Government took possession of the Peruvian monitor 'Huascar.' For reasons which have never yet been clearly explained, the English Admiral considered it his duty to pursue and to endeavour to capture this vessel.

He had at his disposal an unarmoured frigate of the latest construction, of more than 6,000 tons displacement, with a speed of 15 knots, armed with 24 rifled guns, of which two were 300 pounders capable of penetrating the armour of the 'Huascar' at a considerable distance, and fourteen 7-inch guns, capable of penetrating at close quarters, if not in every part, at least the more weakly armoured parts of the vessel. The armament was completed with an equipment of torpedoes. The second vessel at the disposal of the Admiral was an unarmoured corvette, of 1,900 tons displacement, and a speed of 13 knots, with 14 guns, which, however, were not of sufficient power to penetrate the vital parts of the enemy. Both ships had been a long time in commission, the crews were in the finest state of discipline, and the officers were familiar with the qualities of their respective ships. The enemy to which they were opposed was the monitor 'Huascar,' of 2,000 tons displacement and a speed of 11 knots, armed with two 300-pounder guns, and protected with armour of a thickness of 4½ inches, diminishing to a minimum of three inches. The crew consisted of a number of men hastily brought together, whom it was impossible to organise effectively before the action was fought. The officers had no knowledge of the peculiar qualities of their ship. The result of the action fought between these two enemies was that the English vessels had to use the utmost care to avoid the attack of the small vessel to which they were opposed, and whom they were finally obliged to allow to withdraw unmolested from the action. That they escaped with no serious loss was due entirely to the circumstance that the Peruvians had not been trained to fight their guns, and that every shot they fired failed to hit the mark.

If we proceed to compare the capability of resistance, as it exists in the newest armoured ships, with the penetrating power of the

newest guns, we arrive at the result that the conditions are not materially changed to the disadvantage of the ironclads, as compared with the results of the action fought at Lissa between the Italian and the Austrian ships. The guns, of a calibre varying from 26 to 32 c/m., or 10·23 to 12·59 inches, or 18 to 38 tons, to which we have already referred, are a match for plates of from 16 to 20 inches in thickness. The few monster guns of eighty and one hundred tons, whether actually in existence or in construction, are, as we have already stated, of very doubtful value, and may be left out of our contemplation. We may also put aside a few cases of armoured vessels with unusual weight of armour, as, for example, the 'Italia' and 'Lepanto,' built for the Italian Government, which have armour of 28 inches in thickness. The value of such armour in a practical point of view is extremely doubtful, when we consider the enormous size of the ships which alone are able to carry armour of such thickness. *Pro-Memoria.*

The guns are certainly able, under favourable circumstances, to penetrate the armour, and this can be done with shells, but only with shells with a comparatively small bursting charge, so that the effect of the projectiles, which have penetrated through the armour into the interior of the ship, is comparatively limited, and a vessel must be penetrated by a large number of such projectiles before it becomes seriously disabled. It must, however, be taken into view that the projectiles only penetrate the armour when they strike in the most favourable condition, that is to say, at right angles, or nearly at right angles, to the armour. If the shot strikes at an angle, it is either deflected, or is arrested by the armour without penetrating into the interior. Experience has shown that where armour has been practically tried in action, in much the greater number of cases the blows strike under conditions which are unfavourable to the gun. Armour, which in experiments against targets is usually penetrated, in battle affords an effective protection. It may here be mentioned that there are few statistics showing the penetrating power of guns of various calibres. The experiments of the most recent date have been made against the armour of ships which are actually in construction. In these experiments the shots have been shown to be capable of penetrating the armour under favourable circumstances—that is, when making a direct hit.

General conclusions.

Both Krupp and Armstrong (the most famous English constructor) have in recent years produced guns, the performances of which have shown a steady advance. It is still, however, a question how far the guns with enlarged powder chambers will be able to receive corresponding charges. It is further to be observed that by a combination

Pro-Memoria. of steel and iron the resisting power of armour has been considerably raised, so that it is not to be assumed as yet that armour is likely to lose the power of resistance which it has thus far offered to the gun.

Our previous observations may be summed up very briefly as follows: —

1. Unarmoured ships are not able to endure an action of any duration against the powerful guns mounted on board ship and on coast fortifications.

2. Armour still affords an effective means of protection against the projectiles of the heaviest guns for all ships which are intended to engage in an action. Where ships will be subjected to the fire of guns of this description, armour is indispensable.

3. Rams and torpedoes have in any case a small chance of success in a sea fight, and especially where they are used by an unarmoured ship against an armoured vessel.

That this conviction is entertained in the most decided manner by the responsible authorities at the head of every Naval Administration is shown by an examination of the list of ships building for the Naval Powers of Europe. In all cases only a small proportion of the resources at their disposal is devoted to the construction of unarmoured ships. In point of fact, their expenditure is just sufficient to keep up the necessary force of cruisers, corvettes, and other special vessels employed on foreign stations. Far the larger part of the money devoted to shipbuilding is employed in the construction of ironclads. All ships designed to take part in a hard-fought and decisive engagement, all battle-ships, coast-defence ships, and cruisers, which are partly intended to protect our foreign trade, must be ironclads.

Ships in construction. The following is a list of the ironclads, either actually in construction, or the designs of which have been approved by the leading European Powers:—

A. England.

1. The turret ship 'Inflexible.'—This vessel will be ready in May 1881. This is a ship of 11,400 tons displacement, and 8,000 horse-power. The armour plating will be from 16 to 20 inches in thickness. The armament will consist of four 42-c/m., or 80-ton guns.

2. 'Ajax.' This vessel was launched at the beginning of 1880. The displacement is 8,500 tons. The machinery is of 6,000 horse-power, and will realise a speed of 14 knots. The armour plates are compound, and have a thickness of from 16 to 18 inches. The armament consists of four 32-c/m., or 43-ton guns.

3. 'Agamemnon.'—This vessel is now in construction, and is a sister ship to the 'Ajax.' *Pro-Memoria.*

4. 'Colossus.'—The displacement is 9,000 tons. The machinery is of 6,000 horse-power; the speed will be 14 knots. The armour is compound, from 16 to 18 inches in thickness. The armament consists of four 32-c/m., or 43-ton guns.

5. 'Majestic.'—This vessel is a sister ship to the 'Colossus,' and is now in construction.

6. 'Collingwood.'—In construction. The displacement is 9,000 tons. The machinery is calculated to secure a speed of 15 knots. The armour is compound, from 16 to 18 inches in thickness. The armament consists of four 43-ton guns in two barbette towers, and six 6-inch guns.

7. 'Conqueror.'—Turret ship in construction. The displacement is 6,000 tons. The machinery is of 4,500 horse-power. The armour is compound, 12 inches in thickness. The armament consists of two 43-ton guns in a revolving turret.

8. The torpedo ram 'Polyphemus.'—This experimental vessel is due to the persistent advocacy of Sir George Sartorius, an officer of high merit, to whose opinion great value attaches. The 'Polyphemus' must not be reckoned strictly as an armoured ship. The armament consists only of the ram and fish torpedo, and a few light guns to keep off the attack of torpedo-boats. The deck is convex in shape, and is protected with steel armour only 7·8 c/m., 3 inches, in thickness. The displacement is 2,640 tons. The machinery is of 5,500 horse-power, and a speed of 15 knots is anticipated.

In addition to the vessels actually in construction, an ironclad of the first class is about to be laid down, and two armoured cruisers are in contemplation.

B. France.

1. 'Amiral Duperré.'—This vessel was launched at the end of 1879, and is nearly ready for sea. Displacement, 10,500 tons. Horse-power, sufficient to give an estimated speed of 15 knots. Armour, 12 to 22 inches. Armament, four 35-c m., or 46-ton guns in barbette towers, fourteen 14-c/m., or 53-cwt. guns unprotected by armour.

2. 'Amiral Baudin.'—In construction. Displacement, 11,500 tons. Horse-power, not yet settled. Armour, 14 to 22 inches. Armament, three 34-c/m., or 46-ton guns in barbette towers, twelve 14-c/m., or 53-cwt. guns unprotected by armour.

3. 'Formidable.'—In construction. Sister ship to 'Amiral Baudin.'

Pro-Memoria.

4. Second-class ironclads:—'Turenne,' 'Duguesclin.'—Displacement, 5,900 tons. Horse-power 4,000; speed 14 knots. Armour on the water-line 10 inches, on the turrets 8 inches. Armament, four 24-c/m., or 15½-ton guns in barbette towers, one 19-c/m., or 7½-ton bow gun, six 14-c/m., or 53-cwt. guns unprotected by armour.

5. First-class coast-defence vessels:—'Caiman,' 'Requin,' 'Indomptable,' and 'Terrible.'—In construction. Displacement, 7,100 tons. Horse-power calculated for a speed of 14½ knots. Armour on the water-line 14 to 20 inches, on the turrets 18 to 24 inches. Armament, four 32-c/m., or 38½-ton guns in a revolving turret.

6. Coast-defence vessels:—'Furieux.'—In construction. Displacement, 5,600 tons. Horse-power not yet fixed. Armour, on the water-line 13 to 20 inches, on the turret 18 inches. Armament, two very powerful guns in revolving turrets, calibre not yet settled.

The 'Hoche,' 'Marceau,' 'Magenta,' 'Neptune,' all armoured vessels of the first class, will shortly be commenced. In type they closely resemble the 'Amiral Baudin.'

C. Italy.

1. The turret ship 'Dandolo,' completed.—Displacement, 10,600 tons. Machinery, 7,500 horse-power. Speed, 14½ knots. Armour, 18 to 22 inches. Armament, four 45-c/m., or 100-ton guns mounted in a redoubt on revolving turret; in addition there are eighteen 15-c/m., or 5-ton guns without armour protection.

2. 'Lepanto.'—Sister ship to the 'Italia,' on the stocks. In the present year a new armour-clad of the first class will be commenced. The displacement will be 10,000 tons. The armour protection will be similar to that of vessels already mentioned. The armament will consist of four very powerful guns. The details of the designs are not yet settled.

According to the programme which has been laid down, in addition to the ships already mentioned, before the year 1886 three more ships of the same type will be constructed.

D. Russia.

At the present time the only ironclad in construction is an armoured cruiser. Displacement about 6,000 tons. The machinery is designed to give an estimated speed of 14 knots. No exact intimation has transpired with reference to the armour and armament.

E. Austria.

No ironclad is at present in construction. The battery ship 'Tegethoff' has recently been completed and is now fitting out. Displacement, 7,400 tons. Machinery, 7,200 horse-power. Armour, 15 inches. Armament, six 28-c/m., or 27-ton guns. *Pro-Memoria.*

F. Denmark.

The armoured torpedo vessel 'Tordenskiold' is about to be launched. Displacement, 2,500 tons. Armour, 4 to 8 inches. Armament, one 35-c/m., or 51-ton gun in a turret. One 15-c/m., and six 12½-c/m., or 29-cwt. guns.

Another battery ship of 5,000 tons displacement is proposed, but no final decision has been arrived at.

The circumstance that the less important maritime Powers, such as Holland and Sweden and Norway, have no ironclads in construction is not due to a conviction on the part of those Powers that ironclads have no value. The fact is that those states have in recent years completed the programme they had approved for themselves.

Their aim and objects had necessarily been limited in proportion to the means at their disposal. They have now ceased building, but their ship-building programme may be considered as only provisionally completed.

If we examine the lists of their ships it will be found that in all cases, without exception, armour is retained for that class of ships which is intended to take part in a decisive battle. The same remark applies to the case of the coast-defence vessels. The torpedo-boats can only be used with success in a sudden and unexpected attack.

With regard to the value and the use of ironclads for the special services required of the German Navy, and for carrying out the objects in view in the creation and maintenance of the Navy, we may refer to the records, laid before the Reichstag in the year 1873, as a justification for the course then proposed by the Government. The arguments urged at that time may still be used with equal force. In a great war the power of the fleet, as it has been shown in a previous statement in the present paper, depends essentially on the defence of our coasts, and the means at our disposal for preventing a blockade. An effective defence can only be maintained by being able from time to time to undertake serious and important offensive operations. Ship-building policy for German Navy.

The assailant must always be in danger of being attacked in a

Pro-Memoria. weak point by a superior force. Every mistake or delay in the execution of a movement on his side will afford an opportunity to the enemy, acting on the defensive, to defeat the whole plan of attack and to neutralise any advantages which may have been gained by the assailant. It is, however, to be observed, that ironclads alone are able to undertake an offensive defence, and ironclads of sufficient displacement and adequately protected may boldly and openly defy an enemy, and gain a considerable victory off a hostile port.

There have been many discussions on the important problem of giving naval protection on distant coasts to German subjects, whose rights have been wantonly violated.

In order to protect our countrymen abroad we must have naval forces at our disposal, by means of which we may be able in the last resort to compel submission to our just demands. For such a purpose unarmoured ships are no longer sufficient. Powerful guns and ironclads have been distributed to all parts of the world, and we must be prepared to find them everywhere. It is not conducive to the maintenance of the national credit, and to the protection of the interests of Germans living in foreign parts, where we are not absolute masters of the situation, to put forth a claim, or to employ our forces in support of a claim, and not to be in a position to carry out our policy effectually. Sympathy is alienated, and respect is forfeited, where there is an apparent hesitation to appeal to arms. It may be said with truth that our unarmoured corvettes can alone inspire a due respect for the flag, and successfully carry out the duties on which they are employed, if they have behind them, in the home ports, the support of the armoured battle-ships, which can be set in motion when required, to exact by force compliance with demands which have been put forward, in case it should be necessary to refer a question in dispute to the final arbitrament of war.

ITALIAN AUTHORITIES.

Admiral di San Bon.

IN the course of the discussion in the Italian Chamber of Deputies on the Budget, in December 1873, M. di San Bon called particular attention to the subject of the torpedo, and specially to the movable Whitehead torpedo. He then described the torpedo-boat of Commander Mattei, and stated that it was of such formidable power that, if engaged with a large ironclad, costing more than half a million sterling (14,000,000 francs), the advantage would probably remain with the torpedo-boat, the cost of which would not exceed 20,000*l.* *Admiral di San Bon.* — *Revue Maritime*, April–June, 1875.

The invention of torpedoes, he went on to say, would thus exercise as great a transformation in the constitution of a fleet, as the introduction of ironclads. It would be a mistake to construct too large a number of ironclads at the present time.

On the 2nd of March, 1875, in the course of the debate on the Navy Estimates in the Italian Chamber of Deputies, Rear-Admiral di San Bon, the Minister of Marine, spoke as follows:— *Revue Maritime*, July–September, 1875.

'While the ironclads are constructed to resist the gun alone, they could be effectually protected by increasing the thickness of their armour. But since the invention of torpedoes, and especially automatic torpedoes, the bottom of a ship is unprotected. A wooden ship if struck by one of these cheap instruments of destruction would be sunk instantly; and if only one of the compartments were filled an iron ship would be disabled. Moreover, armour no longer protects ships effectually against artillery fire. The guns of the "Duilio" would easily penetrate the thickest armour of the "Inflexible" at 300 yards. It is impossible to have heavier armour for sea-going ships. In future coast-service ships alone will be armoured.

Admiral di San Bon. These special vessels, presenting only the bow to the fortress attacked, will require armour on a limited surface, and may therefore carry enormously thick armour.

'Torpedo-boats are of immense importance. Two or three such vessels might destroy a squadron of ships.'

M. de Laveleye.

M. de Laveleye. The following letter was addressed by M. de Laveleye to Professor Sbarbaro. The criticisms it contains refer to the four large ships of the Italian Navy:—

Liège, March 7, 1880.

'My dear Colleague and Friend,—I can well understand your indignation at the enormous sums which your Parliament continues to squander in military preparations, especially in the construction of the new ironclad ships, on the plea of affording protection to that which no European Power dreams of attacking—I mean the independence of a nation which has gained admittance irrevocably into, and forms an integral part of, the political system of Europe.

'I visited, as you know, last year your building yard of Castellamare, and in my letters from Italy to my friend Count Goblet d'Alviella, which you have read in the *Revue de Belgique*, I have not concealed my painful surprise at the spectacle of such an expenditure on warlike preparations in the midst of your miserable populations. If I am not mistaken, 100,000,000 lire have been expended on the "Italia," "Lepanto," "Duilio," and "Dandolo."

'I have not hesitated to write, and I do not hesitate to repeat now to you, that all this is absolutely senseless.

'I am profoundly convinced that the ships constructed on the type of the "Italia" will be of no use to you. In the first engagement in which they take part they will go to the bottom. Such is the opinion which I have formed from a personal inspection, and upon grounds which I have no difficulty in explaining to you.

'The turret for the guns and the engine-room are the only really invulnerable parts of these monster constructions. All the upper works of the vessel are built with thin plates—the bottom, it is true, is doubled, and the intervening space will be filled with coal. In addition, the ship is divided into numerous compartments; but if we may suppose that two or three of these compartments are penetrated, and every projectile can penetrate them, the water will then make a sudden rush, and the ship will instantly lose its speed and

evolutionary qualities, and will be lost. A small torpedo-boat will easily sink them, as Tegethoff sunk the Italian ships at Lissa with his wooden vessels. These gigantic constructions appear to me the inevitable prey of the torpedo-boats and rams. *M. de Laveleye.*

'You have twelve armoured vessels, but you have not more than four or five in a condition to go to sea, and not one which can be recommended as a really effective cruiser.

'The theoretical instruction of your sea-officers is excellent, but it is deficient in the practical part of the profession. The Italian flag is rarely displayed in distant seas. Your Parliament squander all their available resources on colossal ironclads which no officer will be capable of commanding. Will you allow me to tell you frankly my opinion? You are sedulously preparing all the elements of another catastrophe like that of Lissa.

'Take a lesson from the United States of America, which abound in wealth, and you see them extinguishing, every year, from 100,000,000 to 300,000,000 lire of their public debt. They preserve their old ships, they send them forth to every sea, and thus they train good sea officers, which should be the most essential aim of every naval administration. The march of invention is so rapid in naval architecture that a ship is not completed before it has already become obsolete. It is stated that England herself has not, at the present time, more than three or four first-class ships.

'Your ambition is to possess the most formidable ironclads in the world, but you have not trained up men who are capable of commanding them. Thus, we see in your country, millions squandered from the scanty exchequer of a nation which has to renew and ameliorate the whole mechanism of its civil life; and all this is permitted, and even applauded, because it is in accordance with the chimerical aims of the ephemeral ministries which succeed one another every year in the Government.

'May I ask for what purpose is all this expenditure incurred on your maritime defences? Is it to be imagined that France or Austria would invade you by sea? The time for such expeditions has passed, because the armies of the present day are too numerous to be transported by sea. By making use of the railways and telegraphs, much larger forces can be concentrated upon any point which may be made the object of attack.

'Do you think that, in 1854, England, France, and the heroic Piedmontese would have maintained themselves in the Crimea, if Russia had had its railroads? In 1870, France had the command of the seas, and what, it may be asked, was accomplished by her fleet?

M. de Laveleye.

'Allow me, my dear friend, to repeat in the name of my old affection for your country, the feelings which I experienced in 1878, in the Gulf of Naples, when I had the pleasure of clasping you by the hand as I was looking at the "Italia." "Poor Italian agriculturists, what sorrows, what miseries, what tears, what follies, and what faults!" Do not the hundred millions, squandered on your four absurd ships, in which your Parliament take so great a pride at the present moment, constitute a conspicuous folly—and indeed, a gigantic iniquity.

'Such are the views of an old friend of Italy, views which your old friend Emile de Laveleye has not hesitated to express with frankness to you.'

Signor Acton.

Signor Acton.

Debates in Italian Chamber of Deputies on Navy Estimates, 1880.

Signor Acton, the head of the Italian Navy, in the discussion on the Italian naval estimates for 1880, urged strongly the necessity of building torpedo vessels, which were not less useful than the large ships. The great speed of torpedo-boats, steaming 21 knots an hour, reduced very much the chance of being destroyed, whether by day or at night, by the guns of a ship on the defensive. Their small dimensions and speed justified the employment of torpedo-vessels, at all hazards, against armour-clads, and even made it possible to fight a general action which might have a very decided effect upon the results of a war.

Extracts from the Report of the Debate on the Navy Estimates for 1881 in the Italian Chamber. (17th, 18th, 19th, and 20th December, 1880.)

Signor de Zerbi.

Signor de Zerbi, from a common-sense point of view, did not understand how the increase in the size of ships and in the power of torpedoes could progress simultaneously. For if the progress of torpedoes (which can blow up large as well as small ships) is admitted, what we want is not a few huge ships, but a number of vessels—large ones by all means if we can afford them—if not, smaller ships as well as large. . . .

'What shall we have in 1888? We shall then have those colossal ships which we owe to the skill and perseverance of Admiral Saint Bon and the distinguished Naval Constructor Brin, but in addition to these large ships we shall not have any of moderate size. . . .

These four huge vessels, the finest probably in the world for their sea-going and fighting qualities, are not sufficient to defend our interests at home and abroad. . . . Their draught of water is too great to admit them even to the ports of Brindisi or Venice. . . . *Signor di Zerbi.*

'The logical sequence would have been that, as soon as you had determined to build these big ships, you ought to have commenced the excavation of your ports and dockyards in order that they might have corresponded to the ships you have built. I regret that the Minister of Public Works is not present, as he might have given us an estimate of the expense of deepening the dockyards of Venice and of Spezia, and the ports of Ancona, Brindisi, Leghorn, Syracuse, and Taranto. . . .

'Your huge ships could not pass through the Suez Canal: ought you not therefore at once to begin the construction of at least two ships that could pass through that canal, and, without discrediting the big ships you have already built, at least supplement them by others? . . . With reference to the question of expense:—According to the amount voted by Parliament for ships of the first class these vessels should have cost about sixteen millions (640,000*l.*) each. The four large ships should then have cost sixty-four millions; instead of this they have really cost about a hundred millions (4,000,000*l.*). We have thus a deficit of thirty-six millions. Last year a committee was appointed, consisting of ten Admirals and twenty-two high officials, and they decided by a majority of twenty-two to six in favour of a vessel of the "Acton" type—a vessel between the "Maria-Pia" of 4,000 tons, and the "Tegethoff," the most powerful vessel in the Austrian Navy. It is impossible to continue till the year 1884 or 1885 without a vessel of medium size that could pass through the Suez Canal and enter all our principal ports and yards. We must at once lay down a frigate of this kind, though I fear she will take about four years to complete.'

Signor Alvisi said:—

'In consequence of the rapid development of naval architecture, it is very difficult to forecast the type of the ship of the future. With regard to the construction of medium sized armour-clads we are all agreed. It is very necessary, however, to guard against laying down any ships which might be condemned in a few years as useless. I fully believe in the type of the "Duilio." The best type of a medium sized vessel, however, is a matter of doubt both at home and abroad.' *Signor Alvisi*

In the course of his speech, Admiral Acton, Minister of Marine, said:—'I congratulated myself on the results of the "Duilio," and I drew from them a good augury for the "Dandolo" and the other ships. *Admiral Acton, Minister of Marine.*

Admiral Acton.

I do so again to-day, but a Minister may well congratulate himself on an expenditure which has been successfully incurred without pledging himself to continue in exactly the same path for the future. No one can shut his eyes to the question of progress. . . .

'While, however, I see the old ironclads prematurely failing me, I do not see the new ones completed as had been arranged. The "Duilio," according to the programme of 1877, ought to have been ready in 1879; she is still far from completion.

'The "Dandolo" should have been ready in 1879; she will not be finished before the end of 1881.

'The "Italia" ought to be completed in 1881; she will not be completed before 1884.

'The "Lepanto" should be ready in 1882; she will not be completed before 1885 or 1886.

'The old vessels are disappearing before the new ships are ready to replace them.

'Have I not grounds for apprehension? While, therefore, I congratulate myself on the success of the "Duilio," I must remind the Chamber without entering into any technical questions—that the construction of ships of exceptional dimensions has this grave disadvantage for a small navy in a transition state, that before our new ships are finished we may find ourselves without any navy at all. Every kind of accusation has been heaped upon me outside this Chamber, and no abuse has been spared by my enemies because I have spoken the plain truth. But in a question of such grave import as the security and defence of one's country, should not every personal feeling be hushed and the truth alone revealed? This is what I have done, and my conscience tells me that I have only fulfilled my duty. I have spoken of the question of time; but there is a question perhaps still more important, and that is expense. Can we impose on our country the construction of other ships costing twenty-five millions (1,000,000l.) when we see a wealthy nation like England—with a fleet of more than 300 vessels and 57 ironclads, and estimates of two hundred millions—content with ships that cost a smaller sum?

'In the development of our navy, as our illustrious Admiral justly observed, I see that we have been impelled among the clouds, while other nations incline towards the earth; and while from the year 1873 down to the present time England, in the average displacement of her ships, has been reducing, we have increased in large proportions. Apart now from the question of time and expense, and having regard only to general improvement, ought I to increase the dimensions of our ships or seek to reduce them?

'I do not want to touch on technical ground, but the "Italia," which we have just launched, has a draught of 9·4 metres (30 ft. 9 in.). It is certain that before attempting to carry on an aggressive war we ought to provide for the defence of our own shores. Now let me ask into how many of our ports can the "Italia," with her enormous draught of water, enter? Into no port of the Adriatic, and into few in Sicily. And at what distance must she remain from the coast which she desires to defend? Am I not then right in laying down this principle, that we should have "ships suitable for all the usages of maritime warfare," and ships which may better defend the coasts and the ports of Italy. In order to carry war into the country of another by means of a Mediterranean force, we are limited by certain hydrographical conditions. The Suez Canal has only twenty-six feet of water, the "Italia" has a draught of 30 ft. 9 in. Apart, however, from questions of expense, of time, and of draught, ought not number also to enter into my calculations? Is it the same thing to have the "Duilio," the "Dandolo," the "Italia," and the "Lepanto," that is to say four vessels, as to have one only, which might cost as much as these four put together, and might have a displacement of about 52,000 tons? The answer to this cannot be doubtful. Can it then be the same thing to have in a war four "Italias" rather than eight ships of half their cost? *Admiral Acton*

'There are many dangers to which big ships are more exposed than those of moderate size, while, in my opinion, every service can be equally well discharged by the one as by the other; and observe, that by spending only the half, I can still have the same guns of 100 tons, if considered desirable, equal strength of construction, immense power in the ram, superior powers of evolution, a draught of water more adapted for our coasts (hence stronger for defence and better protection for the ships themselves), and, what is the most important of all, ships constructed in less time. Am I then wrong in wishing for moderate ships? With a coast of more than 3,000 miles, with so many islands, with all our chief cities on the sea-shore? No, gentlemen, it is not the same thing to have four as to have eight ships.

'Perhaps, if you could tell me that with the increase of dimensions the gift of ubiquity would be given to our ships, there would then be something in your argument; but, this not being the case, I understand the power of number in the practical sense other nations have understood it, and as Parliament understood it, when determining sixteen as the number of our first-class ships.

'But in order to divest the question of every degree of personality, and at the same time to have the opinion of those who must live

Admiral Acton. and fight on board these ships, I summoned four commissioners, one from each of the three Departments, and a fourth from the squadron. To these commissioners I proposed certain questions, and without going into details, each of the members of the commission was invited to give the reasons which led him to the conclusions he expressed. . . . Without entering into any technical question, and without wishing to give any judgment upon the subject, I will refer to the opinions given by the different members of the commission. It is the more necessary to do so, because confidence in a vessel of war cannot be commanded but must be spontaneously implanted, and must be deduced from reasons approved by naval public opinion.

'The sailor should at least have faith in the weapon he wields and in the ship which he commands; and I consider that a wise administration would hold in the greatest respect such opinions, which are so many pledges of victory in time of war. (*Bravo! Bravissimo!*). England, the first maritime nation, has attached the greatest weight to the opinions of her naval officers, and the man most eminent for bravery and skill has written to me thus:—

Garibaldi. '"Thanks for the opinions of those excellent naval officers on the construction of ships of war, and the interesting discussions on the bold design and execution of the four colossal ships which excite the envy of foreigners. As to the necessity for smaller and more numerous ships, I coincide with the opinion of the majority.

'"A fleet will be so much the more formidable in proportion as it is furnished with rams, like the English 'Polyphemus,' adapted for carrying Whitehead torpedoes, and especially endued with great speed for attacking an enemy in flank with the spur."

'"Yours gratefully,
'"G. GARIBALDI."

'"Caprera, Sept. 18, 1880."

'I pass on now to the opinions of the members of the commission.

'Admiral Martini says in his report:—

Admiral Martini. '"I believe it is possible, nay more, I consider it desirable, to attain our purpose with ships not exceeding 8,000 tons, as more manageable, less expensive, and having less draught of water."

'Admiral Piola writes:—

Admiral Piola. '"I declare it to be my opinion that we should construct ships of about 8,000 tons capable of engaging with any force at present existing."

'Admiral Fincati says:—

Admiral Fincati. '"I am convinced that these strong and rapid ships, armed with rams, of about 6,000 tons, intelligently commanded by men acting in

concert, resolute, and determined for any sacrifice, would undoubtedly beat any one ship equal to or even much superior to their united tonnage, and necessary to their total cost, however ably that one ship might be commanded. That is to say, with the view of increasing our naval force, and speaking of ships of not less than 6,000 tons, I immensely prefer to increase their number rather than their dimensions and armament." *Admiral Fincati.*

'Admiral Martin Franklin writes:—

'"It is not only desirable but necessary that the ships we intend to construct should not exceed 8,000 tons displacement, that they should have moderate length and great breadth, in order to obtain sea-going qualities, and that they should draw not more than 7½ metres (24 ft. 6 in.)." *Admiral Martin Franklin.*

'Admiral Baudin writes:—

'"The necessity for diminishing the size of the two new ships as compared with the 'Italia,' is a consequence of the latest experiments in artillery. A type of vessel which shall have a displacement of about 8,000 tons, and whose draught shall not much exceed 7·30 metres (24 feet), can unite all the qualities necessary for a man-of-war of the first class, can be adapted to our finances. Such a ship is easy to be handled, and strategically suited for national defence." *Admiral Baudin.*

'Captain Civita writes:—

'"It is not only desirable but necessary to construct ships of a much less displacement than the 'Italia' and the 'Lepanto.' I am of opinion that a ship of 8,000 tons displacement is the best war vessel, because it allows of the union of all the necessary naval qualities, more especially speed and rapidity of evolution and an armament as powerful as that of the colossal ships." *Captain Civita.*

'Captain Racchia writes:—

'"What would be the fate of the ironclad 'Italia' were she surrounded by three or four ships well armed and well manned, each of 8,000 or 9,000 tons, and of a speed not less than 15 miles? Would our country be satisfied with the announcement that the 'Italia' has gloriously struck her flag after having sunk or placed *hors de combat* a couple of the enemy's vessels, whose total value was scarcely equal to that of the 'Italia' alone, leaving afloat, perhaps intact, two or three other hostile ships of much less dimensions than herself, free to bombard Palermo or Naples, or to cover the disembarkation of troops rendered possible by the retirement of the 'Italia'? How will the commander of a ship like the 'Italia' or the 'Lepanto' dare to face with a light heart the consequences of charging with the ram a ship of 8,000 or 9,000 tons, knowing that *Captain Racchia.*

Captain Racchia. his ship alone constitutes the half, the third, or the fourth part of the offensive naval power of his country?

'"The slowness of the fire with the huge guns of to-day, and the always uncertain chances of hitting, appear to me considerations of such grave importance that they should make us hesitate before spending vast sums in order to increase the dimensions of the war-vessels of to-day, with the view of placing on board them guns of boundless weight and cost."

'Other very weighty and important observations of Captain Racchia I would wish to mention here, but I should make a poor return for the boundless confidence imposed in us by distant and eminent officers abroad if I were to be silent as to their opinions. Moreover, what I have already quoted from Captain Racchia seems to be sufficient. I am sorry, gentlemen, to read so much, but with your permission I will continue, since they give the general opinions of our naval officers. ('Continue! Continue!')

'Captain Sandri writes:—

Captain Sandri. '"If Italy should find herself engaged in a war, the sphere of action for her ships will doubtless be the seas which surround her coasts, and her regular naval force will certainly not be sufficient to enable her to entertain other projects. We have emigrants scattered in every part of the world, but our emigration is the most extensive in the republics of Uruguay and Argentine. Now at La Plata, in order to be at a convenient distance from Montevideo ships with a draught of little more than six metres (19 ft. 6 in.) would be necessary. Thus our large men-of-war could not be sent into these waters.

'"In my opinion the dimensions of the ships now to be constructed should be limited to a displacement of perhaps less than 8,000 tons."

'Captain Martinez writes:—

Captain Martinez. '"The necessity for urging the diminution of size is inferred from the conditions to which it is desired that the vessel should answer. The constructor should make the smallest possible vessel which will fulfil the requisite conditions.

'"In spite of the admiration with which I am filled for the splendid work, for the ingenuity and ability of our naval architects, I cannot quite shake off some doubts which impress themselves on my mind as to the complete efficiency of these ships in the various phases of war.

'"There are two considerations:—

'"I. Will it not in many cases be a serious drawback to the 'Italia' that she has a draught of 9·40 metres (30 ft. 6 in.); and will not

this prevent her from acting in many places where the depth will not permit her to cruise? *Captain Martinez.*

'"II. Will not her length of 122·70 metres (400 feet) render her unwieldy and slow in her evolutions? A third consideration presents itself to me. With the sum which the 'Italia' costs, would it not be possible to construct two—or with the cost of three 'Italias' to build five ships more easily handled and of a more suitable draught of water? It appears to me that the ships we have to construct should be of less size and draught than the 'Dandolo,' 'Italia,' and 'Lepanto,' and fulfil the following conditions: first, that they should be armed with guns of a perforating power at least equal to that of the most powerful guns of foreign ships. With the exception of the 'Inflexible's,' which are the only guns in the world that beat the 'Italia's,' I believe that guns of 40 tons or a little more would be sufficient; the English have hitherto limited themselves to 38 tons; our 100-ton guns have the disadvantage of too long an interval between the shots. Until these can have a greater rapidity of firing, and are superior to those of other navies, it appears to me undesirable to arm our ships with monster guns."

'Captain Manfredi writes:—

'"1. A ship, in order to be well directed and to be like a docile instrument in the hand of its commander, ought not to be of colossal dimensions. *Captain Manfredi.*

'"2. In exceeding a certain limit in the size of ships, all its organs necessarily become more complicated, manual labour giving place to mechanical aids even in the simplest operations. This is an endless cause of inconvenience, by reason of the complications introduced.

'"3. A colossal ship is more exposed to dangers of collisions, more liable to run aground, offers a better mark to the enemy, is open to attack from smaller vessels armed with a ram or torpedoes, and in the event of her being temporarily disabled, would fall an easy prey to smaller adversaries.

'"4. These large ships require longer time for their construction and even for small repairs. Their complicated and numerous mechanisms are subject to frequent accidents, which all result in extra labour and loss of time."

'Captain de Liguori writes:—

'"The great draught of these colossal ships, their doubtful nautical qualities, the slowness of their fire caused by the small number of their heavy guns, the consequent decreased probability of hitting, the increase of their cost, the necessity of trusting the fate of the battle almost exclusively to the workings of complicated machinery, the *Captain de Liguori.*

Captain de Liguori.

difficulty of following out strategic plans, the impossibility of dividing the forces on account of the small number of the ships; these are all weighty arguments. If, before the adoption of breech-loading guns, distinguished officers maintained the opinion that a number of ships armed with rams would prove fatal to the largest vessels, although armed with the most powerful guns and themselves invulnerable, how much greater force would there be in the argument with the now increased force of guns of moderate weight and the consequent vulnerability of the thickest armour plates?"

'I could read much more, but I will content myself with quoting in conclusion Captain de Luca:—

Captain de Luca.

'"The problem of the type of men-of-war which is presented to us to-day may be stated as follows: Given a certain time, shall we turn it into a greater or less number of ships? If we give the preference to numbers, each ship individually will have less fighting power, but the aggregate may represent a far more formidable contribution of force. Given a sum of 50 millions (2,000,000*l.*), with which we might build one gigantic ship, or two of 25 millions (1,000,000*l.*), or five of 10 millions (400,000*l.*), there is no doubt that the ship of 50 millions would be more powerful than one costing 25 millions, and that these two again would be more powerful than those of a type which could be built for 10 millions; but this is no good reason for giving the preference to the ship of the largest type."

'It is necessary to compare the ship costing 50 millions with the two costing 25 millions, and these again to the five costing 10 millions. Captain de Luca with a careful analysis examines this delicate problem and comes to the following conclusion:—

'"Judging from existing ships abroad, and from the project of ships of 13 millions (520,000*l.*) proposed by the Ministry, I hold that the shipbuilding problem may be solved with a ship of 7,000 tons displacement and costing 440,000*l.* Every saving on the cost of each individual ship may be applied in increasing the aggregate strength, in building a greater number of ships, and providing an increased number of guns, of torpedoes, and above all of vessels armed with the ram.

'"I do not conceal my satisfaction at seeing that my plans have been approved by the majority of the officers at the head of our Navy. I have experienced an equal satisfaction in seeing that England is travelling on the same road which for a whole year I have pointed out to Parliament. She constructs the 'Conqueror' and the 'Collingwood' with 30 c/m. (12 inches) of armour, and other ships of still smaller dimensions. Indeed, the mean tonnage of her armour-

clads does not exceed 6,400 tons. France, while continuing the construction of two large ships of 11,000 tons, which are smaller than our two latest ships, is constructing four ships of 5,500 tons and two of 4,000 tons." *Captain de Luca.*

'I must now remind the Chamber of a question that has not yet been thoroughly investigated in Italy, a question the importance and value of which we have not yet accurately estimated. I speak of torpedo-vessels. For my part I firmly believe it is impossible to exaggerate the importance of providing torpedo-vessels. The most recent experiments have incontestably proved that these "sharpshooters of the sea" may in broad daylight dart out on the most powerful ironclad and destroy her. **Torpedo-boats.**

'It will be easily objected that these torpedo-boats may be sunk by the guns of the ironclad which they attack; but I would observe that an ironclad costs from 15 to 25 millions (600,000*l.* to 1,000,000*l.*), while the best of the torpedo-boats, with a speed of 21 miles, does not exceed 253,000 lire (10,000*l.*). But the most powerful ironclad, if attacked simultaneously, even in broad daylight, by ten of these torpedo-boats, would be in great danger. If she has not other torpedo-boats to oppose to them, and must fight by herself alone—though she may certainly be able to sink five or six, or perhaps even more of them—yet, in a simultaneous attack conducted resolutely and skilfully she would probably be destroyed. Two out of the ten torpedo-boats might succeed in getting at the underneath part of the colossal ship and sinking her. This terrible result would be all the more disastrous, because the ten torpedo-vessels engaged in the attack would not have cost more than one-tenth the value of the ironclad which they had destroyed.

'Any comment on this I consider superfluous; but I must add that, even to a greater degree than in a war of offence, the torpedo-vessels are elements of a mighty power in the defence of our extensive coasts.

'It is not possible to exaggerate the urgency of providing torpedo-boats. England already possesses 70, and is constructing more every day. Russia already has 110, France 66, Denmark 8, Holland 12, Greece 20, while in Italy we have only two torpedo-boats.'

In the adjourned discussion Captain Albini spoke to the following effect:—

'Large ships represent the nucleus of great forces, that is to say, by analogy the bulk of the army, *i.e.*, the infantry; the other ships *Captain Albini.*

Captain Albini.

represent the subsidiary troops which are requisite for them, *i.e.*, the cavalry, the engineers, and other divisions. . . .

'I believe that we may well discuss the advisability of constructing some ships of moderate size in limited proportions, in order to assist, as I have said, the larger ships; and I earnestly entreat the Chamber to concede this addition to the Navy List in order to obtain a naval force corresponding to the aspirations of our country.

'If the Chamber should not intend to approve this increased expenditure, it might be necessary to substitute (mark well the word "substitute") for large ships others of moderate size. I declare I would never cease to deplore such a measure, which I should consider as a negation of progress, as a want of foresight, and as a true calamity for the country. For a nation of limited financial resources I believe that it is better to possess a few formidable ships, which in power may be in advance of the times, rather than to possess a number of moderate sized ships which may become antiquated as soon as they are built, which are not in a condition to maintain their efficiency in the face of rapid changes, and which would be in danger after a short interval of imposing on the country the necessity of reconstructing its naval forces. . . . .

'Admiral di San Bon, with the fine perception that characterises the man of genius, knew how to foresee and provide against being caught unawares by these sudden changes. His searching eye knew well how to scan the horizon and to discern the coming changes, without allowing himself to be deceived with momentary pauses so deceptive to weaker minds.

'We owe it to his brilliant design, in which he was so ably assisted by Signor Brin, that we now for the first time have ships that are not condemned as antiquated as soon as they are constructed, but which are condemned on account of their excess of strength. Let us rejoice in this defect, since it is a defect which will allow us to see them for fifteen or twenty years as towers of strength on the sea, always emblems of our great power.

'It appears to me that the time has now arrived when we should cease from calumniating our bold national design. Ought we to abandon it because we have no imitators? It appears to me folly to think so. In my opinion it is inaccurate to say that we have no imitators, since we see France following on this very path by laying down in her dockyards ships which—if not exactly identical with the "Italia"—are very slightly different from her; and I am firmly convinced that in a very short time many more will follow her example.

'Some quote England. But do you suppose for an instant that

England can long remain in a state of listless apathy, and contemplate with indifference the possibility of seeing our powerful ships carrying guns of 100 tons, to which might be joined French ships with equally powerful ordnance, and thus making her give up the supremacy of the Mediterranean? You can, gentlemen, if you please, indulge in these illusions; but I have lived too long in England. I know our friends too well to participate in such an error. *Captain Albini.*

'Remember that when France initiated the era of ironclad fleets by constructing the first ironclad, the "Gloire," England appeared to take no notice of this bold design, every English newspaper laughed at it, and the Government itself appeared to join in this opinion by laying down in the dockyards unarmoured wooden vessels, thus following the old system. But when she saw that France took no heed of her censures, but continued on her own course, then she began to lay down in her yards not one but two ships, and prepared the plans for a third; then we all know with what diligence and with what energy England set herself to make up for lost time, how she at once laid down two ships larger and more powerful than those of France, and how in a short time she was able to surpass her rival.

'In my opinion this momentary reluctance on the part of England arises from the same causes which have always been in operation every time that other nations seek to concentrate great power in one single vessel. England, with her vast colonies scattered all over the world, has need of an extraordinary number of ships; and therefore her policy and her interest lead her to oppose the increase in the power of single ships, because otherwise she would be forced into a fabulous expenditure. I attach no value therefore to this apparent reluctance on the part of England. . . .

'There is another reason why we have not been so rapidly imitated in our great ships. The "Italia" was already half constructed, not only before foreign nations knew the details of her construction, but (and this I can assert without fear of contradiction) before the naval constructor himself, who directed the building of the vessel, possessed the complete designs; and this scrupulous reserve—which was specially directed by San Bon—was inspired by the patriotic desire of keeping other nations from imitating us, and thus preserving as long as possible to our country the advantage of having ships more powerful and more formidable than any at that time existing. But now that we have obtained this result, that we possess the most powerful ships, are we to condemn them? Great ideas and great projects, by a natural law, pursue their course but slowly. . . .

'Suppose for an instant, gentlemen, that you are men of property

Captain Albini.

desirous of employing your capital in a particular foreign business. With this idea you summon a competent shipbuilder, and you explain to him the sum which you intend to expend and the principal requisites of the vessel for the business you have determined to embark in. The constructor, after having studied your problem, comes to you and says, "This is the plan of a ship which is within the sum you have determined to expend; she has all the qualities necessary for your traffic; but I cannot guarantee that she will maintain these qualities for four or five years, if in the interval important changes take place in your business. But if you will expend a fifth or a sixth more than the sum which you have determined upon, I can guarantee a ship which will not only answer your purpose now, but which it is ninety-nine chances to one will continue to do so for fifteen years, even if great changes shall have meantime taken place."

'What is the decision that you would come to in this matter?

'It appears to me that you would decide to select the ship which has all the requisites for present wants, and gives you confidence that in the immediate future it would not be necessary to incur a larger expense.

'This, gentlemen, is a fair statement of the question, as between large and small ships of war. With small ships of war you may barely succeed in obtaining the requisites for the time; but you have no guarantee that you will continue to do so for a period of five or six years, if in that period important changes in engineering should take place. With a large ship you are sure of being able to satisfy the requirements of fifteen or twenty years, even though in that time considerable changes shall have taken place.

'But here it is necessary to make the same calculation that you have made for your merchant ship: you have to estimate the probabilities of future changes. You see, in the first place, continual changes in engines and in boilers. All new ships will be endowed with superior speed—a quality all the more requisite when we see the increased numbers of very swift cruisers and torpedo-boats, to which allusion was yesterday made by the Minister. The highest rate of speed will be of the utmost importance for our new ships, if they are not to be absolutely inferior to those in course of construction by other nations.

'We see the manufacturer of armour-plating making greater progress than ever. The immense resistance recently obtained by the amalgamation of iron and steel is preparing a new era in the resistance of armour-plating. An economy in weight unlooked for

eight or ten months ago, and which cannot be realised with guns, has been effected. *Captain Albini.*

'I do not hesitate to declare that I was among those who rested in the hope of a triumph gained by ordnance of moderate size, but the maker of armour-plating has disappointed our hopes. He will in a short time be in a position to give us armour capable of resisting even our 100-ton guns.

'I sincerely trust that my country may not be compelled to employ guns of greater size than 100 tons, but I greatly fear that such good fortune will not be her lot. . . .

'Five years ago locomotive torpedoes were only capable of developing a speed of eight miles an hour, their course was uncertain, and the chance of their hitting very doubtful. In 1879, we have seen these torpedoes acquire a speed of 18 knots; in 1880, of 25 knots; and I believe I am venturing on no empty prophecy when I say that in two or three years we shall see them attain a speed of 30 miles. You will easily understand that the chances of hitting increase in a great measure with the increase in velocity; and consequently you see what a powerful weapon this may be for future ships. If you wish effectually to guard against it, there is no other means of obtaining your end except in the construction of large ships, because it is only with a very large space between the skins of the ship that the intensity of the damage can be diminished.

'Without wishing to enter into any speculation as to the intensity of the effect of torpedoes, I would simply say that the effects of this weapon are very violent at the centre of explosion. They rapidly decrease, in proportion as the distance increases, and at fifteen or sixteen feet the effect may be considered as *nil.* Thus a large ship would be in the condition of a person whose cloak had been pierced by a poniard stab, but who escaped without a scratch. This comparison represents the relative chances of large and small ships. It is admitted by many competent authorities, that in future naval engagements great use will be made of torpedo-boats. It is therefore necessary to guard against this new instrument of attack.

'To do this you must increase the number of your small guns, and repel the attacks of these torpedo-boats with boats of a similar kind. Your ships must carry a sufficient number of these boats to compete on equal conditions with the enemy, and this result you cannot obtain with small ships. You may indeed carry a couple of torpedo-boats in a small ship of 7,000 tons; but you will have difficulty in doing so. On the other hand, in large ships you can carry five or six of these boats without inconvenience. In short, by con-

Captain Albini. tinuing the enumeration of the dangers which you see on the horizon, you may convince yourselves that everything points to great changes, and that you cannot meet the exigencies of the case without having recourse to large ships.'

Signor Ricotti. Signor Ricotti, after some introductory remarks, entered into a history of the 'Italia.' He showed that, when she was first commenced in 1875, it was intended that she should have two guns of 100 tons, a total displacement of 13,700 tons, and a draught of water of 30 feet. These figures were increased in 1877. The armament was increased to four guns of 100 tons. The displacement was raised to 14,400 tons. The draught of water was increased to 31 feet. It was proposed that a fifth ship should be laid down, which should be an improved 'Italia' but with only two guns of 100 tons. The difference between the two and four guns is not so great as at first sight might appear. The number of projectiles on board in both cases would be 200 (aggregate weight 200 tons), the additional guns being chiefly desirable as a resource in case of accidents. But though this fifth ship had been authorised two years ago, she has never been commenced; and it is now proposed to substitute instead two ships of the 'Acton' type.

The speaker quoted the opinion of Captain Acton, brother of the Minister, that it was impossible to have a vessel, with all the requirements of the first class, with less than 10,000 tons displacement and a draught of less than 26 feet; and declared that if all the evidence had been fairly represented it would have been most unfavourable to the 'Acton' type.

He complained of the conditions imposed by the Minister in his programme, 'that the draught of the new vessel when fully equipped should not exceed 24 ft. 6 in., in order to allow of her passage through the Suez Canal.' For Italy, however, the question of paramount importance was the defence of her coast.

The speaker then compared the reduced speed of 16 miles of the 'Acton' vessel with the 18 miles of the 'Italia'; and quoted the combat of the Horatii and Curiatii to show the vast importance of speed as enabling a vessel to advance or retreat, and thus choose the time and place of combat. The 'Acton' type would only be able to compass, at 10 miles an hour, a distance of 3,500 to 4,000 miles without coaling, as compared with the 7,000 of the 'Italia.'

The French ironclads carry 120 charges per gun, the English 170, the 'Acton' only 50.

Four vessels like the 'Italia,' with their superior armour-plating and ordnance, with their increased power of resistance to the ram or

the torpedo, with their superior speed and coal-carrying capacity, would be superior in offensive and defensive qualities to eight ships of the future 'Acton' squadron. Calculating the expense of construction at 2,000 lire (80*l.*) a ton, and putting one class at 12,000 tons and the other at 8,000, the expense of four 'Italias' would be 96 millions (3,840,000*l.*), and of eight 'Actons' 128 millions (5,120,000*l.*), an excess of 1,280,000*l.* *Signor Ricotti.*

Signor Ricotti concluded his long and eloquent speech by proposing that, in addition to cruisers, despatch vessels, rams, and torpedo-boats, the fleet should consist of six or eight vessels which could compete in point of strength with any of those of France or England, and thus carry out the programme so hopefully initiated by San Bon and supported by Brin. (Great applause.)

Admiral Acton, Minister of Marine, in reply said:—

'It has been said that France has pushed forward more than ever in the building of colossal ships. From official documents, however, it appears that in France there are nine ironclads of the first class which have a displacement of less than 6,000 tons; and that of her 25 ironclads of the first class, two alone, which are still in course of construction, about equal our "Duilio," *i.e.*, 11,000 tons. From these official documents we see that the French armour-clads at the water-line are entirely protected with an armour-plating of 22½ inches amidships. France has no ironclad of 15,000 tons and drawing 30 feet, like our "Italia" and "Lepanto," and without any vertical armour-plating at the water-line. France, besides her 25 ironclads of the first class, has built two ships with 4,000 tons less displacement than ours. *Admiral Acton, Minister of Marine.*

'These are the facts for the present. For the future we learn from official documents that the "Hoche," "Neptune," "Marceau," and "Magenta," which are on the point of being laid down, will be built of iron [? and steel] after the plan of the constructor Huin. Their plating will be of a thickness of 17¾ inches; their engines, with a force of 6,000 horse-power, will give the vessel a speed of 14 knots. The armament will be composed of three 34-c/m. [13-inch 46-ton] guns in turrets, and eighteen 14-c/m. [5½-inch 53-cwt.] guns on the main deck. It has been said that England has not followed our example from pure Machiavellism. But from official documents we see that, from 1873 down to the present time (that is to say, from the commencement of the "Duilio"), England has spent on her Navy 2,376 millions (95,000,000*l.*); and out of her 57 armour-clads she has only one ship of 11,400 tons to meet our

Admiral Acton.

"Duilio" of 15,000 tons. In nine years, with little less than 350 millions (14,000,000*l.*), we have wished to construct four great ships. Comparing this with the 95,000,000*l.* expended by England, whose fleet does not contain a single "Italia," I find it indeed strange to speak of this as Machiavellism. From other official documents it appears that England is not only content with having followed this path of moderation, but desires to be yet more moderate for the future.

'Our Naval Attaché in London wrote to me in November last:—

'"At this moment the reaction against huge guns and huge ships is more active than ever in England.'" . . .

'Before I assumed the portfolio of Marine I always considered Captain Albini to be a strenuous supporter of colossal guns, colossal engines, colossal ships; and I confess Captain Albini, as the Director-General of Ordnance, in expressing his preference for big guns, had a great weight with me. But in January of this year I found in our *Naval Review* an article by Signor Albini in which he thus declares his opinions:—

'"It is a mistake to suppose that an excess of power in ordnance can constitute an advantage for long ranges, while it has the disadvantage of great slowness in firing and decreased probability of hitting." "Some," continues Captain Albini, "are inclined to give little importance to slowness of fire and deficiency in the number of guns. They consider that in modern naval warfare they will never succeed in obtaining a rapid and continuous fire, and the aim should be to maintain a slow but well-directed fire. I do not concur in such an opinion. Those who propound it calculate that every shot will hit, while practice demonstrates how small is the proportion of hits.

'"They take no account of the numerous accidents which so often happen in the ordinary service of guns, and which in a moment paralyse their action. They do not reflect that the capability of a rapid fire does not involve the necessity of firing at random, but only provides the means of being ready to act effectually at the moment of need. To allow the enemy to pass without having time to reload the guns is equivalent to being disarmed. They forget, besides, that it is ridiculous to insist so much on the necessity of constructing ships with great powers of evolution if their guns cannot act in unison with this quickness of movement. The time which transpires between one shot and the other is double the time which is required to effect a complete circle in ships of the type of the 'Duilio' or the 'Inflexible.'"

'Captain Albini has laboured with me in the construction of the

type of ship of 7,500 tons. I was justified, therefore, in considering that he held to the opinion expressed in his article. Yesterday I heard with surprise that he had changed his opinions. . . . *Admiral Acton.*

'I do not intend that the new ship should cost more than fifteen millions (600,000*l.*) Her tonnage will not exceed 9,000.

'With regard to the accusation of change in our opinions, I will quote the following official statements:—

'"The four large ships of the first class already designed, one of which has already been completed, the others being in different stages of completion, satisfy in an eminent degree the condition of the maximum power for offence and defence; but it appears to me that their size may render them less suited for the exigencies of naval warfare, and that if we continue to construct ships of a great size and cost we shall not have sufficient numbers to provide substitutes for the ironclads which drop out of our list."

'And again:—

'"It appears to me that the sixteen ships of the first class ought to comprise the various types of vessels for fighting against ships or forts. And as we have at this moment, either completed or in course of construction, four very large ships, it would be desirable to construct two of moderate draught and dimensions more adapted for coast service and the hydrographical conditions of Italy. On account of their more rapid construction, these may fill the gaps which our old ironclads may leave in our lists."

'Before replying to the various technical points raised by Captain Ricotti with respect to these new ships, I maintain that it is not a question of the "Acton" type, or the "Saint Bon" type, or the "Brin" type; because the difference of the types does not depend on either displacement or draught. In the "Duilio" we have maintained the armour-plating at the water-line for the central redoubt alone. In the "Italia" we have given up the vertical armour-plating at the water-line.

'The French protect with armour the entire water-line; the English follow the same rules that we have adopted for the "Italia." The ship that I propose to construct is of the type of the "Italia," but adapted for repairing in our ports in the Adriatic, and for passing through the Suez Canal. Captain Ricotti made it a great point that this new ship would only have a speed of sixteen knots, which is inferior to that of the "Italia." I will tell him my reasons for this. A speed of sixteen knots I consider sufficient, because it is superior to all other ironclads in existence or in course of construction.

'The reason we sought to obtain for the "Italia" a speed of

Admiral Acton. 18 miles depended on the fact that torpedo-boats had at that time obtained a speed of only 16 to 17 miles. But directly they reached a speed of 21 miles it appeared to me no longer worth while to make enormous sacrifices, and after all to be in a condition inferior to them with regard to speed.

'I would beg the Chamber to seriously consider the following facts: In order to increase from a speed of fifteen to a speed of seventeen knots, we have been obliged in the "Italia" to pass from machinery of 10,000 to machinery of 18,000 horse-power. I have reduced the provision for coal, because I consider the provision made in the "Italia" excessive. The guns of the new ship will be 650 tons as compared with 700 in the "Duilio," a reduction of 50 tons, which can easily be effected without diminishing their offensive power by availing ourselves of the improvements made in gunnery. Finally, I declare that it is not a question of changing the type, but of following the same type and rendering it more adapted to our actual wants.'

On a subsequent day of the discussion Signor Morana said:—

Signor Morana. 'England and France have these colossal ships in the proportion of two to thirty, or two to fifty; we have them in the proportion of four to nothing. England has always opposed certain inventions, especially that of Fulton, the inventor of torpedoes, because, as Earl St. Vincent said, "Torpedoes are the arms which place poor nations on an equality with the rich, who alone are able to construct large vessels."

'Austria has her "Tegetthoff," and Germany her "Sachsen," "Würtemburg," and "Preussen," of from 7,000 to 8,000 tons, with six guns capable of piercing the armour of the "Duilio," and which have armour-plating of 17¾ inches, besides the vertical protection of coal.

'The "Italia," a ship of 15,000 tons, carries 700 tons weight of artillery. It should be 1,300 tons. The new ship of 8,000 tons will carry 670 tons, an inferiority as regards weight of fifty tons, but a reduction in expense of 10 million lire (400,000*l.*). Moreover, the 700 tons of ordnance of the "Italia" consist of guns of 100 tons, which have no greater force than those of the improved 50-ton guns.

'The "Italia" and the "Duilio" represent two opposite conceptions: the "Duilio" that of extreme defensive power based on armour-plating; the "Italia" the abandonment of armour-plating. The new ship follows the "Italia," but with smaller dimensions and more powerful ordnance.

'We must not forget what has happened to France. She had spent 120 millions of francs (4,800,000*l.*) on her Navy; and in the

hour of her need, in 1870–71, her fleet was useless and inoperative: and why? Because they drew too much water.' *Signor Morana.*

Captain Ricotti, in some further remarks, said:—

'If we were to build eight ships like the "Italia" we should spend all our fund of 200 millions (8,000,000*l.*), and yet should not have the sixteen ships assigned by law. In my opinion the other ships ought to be small monitors.' *Captain Ricotti.*

THE COMPILER'S SPEECHES IN PARLIAMENT.

(*Reprinted from Hansard's Debates.*)

State of the Navy; Ironclad Ships; Observations.

Mr. T. Brassey

July 8, 1875.

Progress of construction.

THE motion I have placed on the paper embraces both armoured and unarmoured ships.

While the principles I seek to enforce apply equally to either class, for the sake of brevity my observations shall be confined to ironclad ships. I may at once explain that, in recommending that an effort should be made to combine the more essential qualities of a man-of-war with reduced dimensions, I do not desire to criticise in any unfavourable sense the ship-building policy of the past. The ships designed by the Hon. Member for Pembroke (Mr. E. J. Reed) and his successors are admitted by the most competent authorities abroad to be superior to any yet built in their own naval yards. We have been going with the times, and keeping well ahead of other nations. On the other hand, it will be admitted that much disappointment has been felt that the number of fighting ships we have been able to turn out has been year by year diminishing. During the last ten years we have launched on the average two ironclads annually. The former average was insufficient, and there had been a marked falling off in the last three years. In 1870, six ships were launched, including three of the 'Audacious' type, and the 'Hercules' and 'Sultan,' which still remain the most powerful masted ironclads we possess.

In 1871 we launched seven ships; but four of these, of the 'Cyclops' class, were comparatively small, and intended only for coast defence. In 1872 we launched three ships, the 'Devastation,' 'Thunderer,' and 'Rupert.' In the two succeeding years no additions were made to our armoured fleet, and when the 'Alexandra' was recently launched at Chatham, an interval of nearly three years had elapsed since an ironclad had been added to the Navy. The cause

of this stagnation is not so much the insufficiency of the estimates as the extravagant cost of the individual ships. Previous to the ironclad epoch a ship of war could be built for 1,000*l.* a gun. The cost has now increased to 125,000*l.* a gun, and these figures, large as they are, may be considerably augmented before the 'Inflexible' and the 'Dreadnought' are completed. Such an outlay is the less satisfactory at a time when questions are being raised as to the policy of building these enormous ships under the altered conditions of naval warfare. *Mr. T. Brassey.*

I may here explain that, in insisting on the policy of building ships of more moderate dimensions, I do not seek to reduce expenditure. Previous to the Franco-Prussian war, it might have been possible to bring down the Naval Estimates to a sum not exceeding 10,000,000*l.* Since that tremendous struggle the armaments of the Continental powers have been permanently increased; and our position is necessarily affected by the policy of other nations. The particular amount required must be determined by the responsible Ministers of the Crown, and they need never shrink from asking for what is necessary to maintain an efficient Navy.

Modifications of type reluctantly accepted in England.

The Naval Estimates have been often criticised, but the criticisms have been directed not so much to the aggregate amount as to the injudicious application of the money voted to the Naval Service. The most rigid economists in the House of Commons have no desire to starve the Navy, though they are anxious that our effective strength shall be proportionate to the outlay incurred. It is one essential condition of economy in expenditure that all sudden fluctuations, whether of increase or reduction, should be avoided. It is equally essential that the designs we adopt for our vessels of war should be framed in accordance with the latest and most approved ideas in construction. When we review the past history of the Navy, we find many instances where we have been too obstinate in resisting inevitable changes in the system of naval construction. We have clung to the accepted types because a reversal of policy would have been tantamount to an admission that the fleet, which we had created at great pains and cost, had become obsolete, or, at best, of little value. It is my object to prevent a similar error in our own times, and I venture to think the present occasion is not altogether inopportune. The estimates before us include two armour-clads, on each of which it is proposed that only two workmen shall be employed. A force so insignificant can make no appreciable progress in the herculean task in contemplation. Modification in the designs at the present stage would therefore involve no very serious loss.

Mr. T. Brassey.

Objections to extreme displacements.

It is undoubtedly most difficult to form a distinct conception of the future requirements of the *matériel* of the Navy. But the problem must be faced. The other maritime Powers are not dependent, like ourselves, for their very existence on the command of the seas. They can afford to await the result of our costly experiments. We are in a different position. The question we have to decide is not, whether we shall or shall not for a time suspend our shipbuilding operations, but rather what type or types it is most advantageous to adopt, having regard to the actual and prospective conditions of naval warfare. We must therefore make up our minds on a number of questions, which it is more easy to suggest than to answer. Are we right in building ships of monster size solely for the purpose of carrying armour, ponderous in weight, but no longer impenetrable? In the Middle Ages armour for personal defence was gradually increased in weight, until it became an unsupportable incumbrance. Our vain endeavours to give protection to ships of war seem likely to lead to a similar result. It is practically impossible to give more than a partial protection to ships of the largest tonnage against the guns already introduced, still less can it be practicable to withstand the irresistible ordnance in process of manufacture.

In 1871, the Committee on Naval Designs reported that we were approaching a period when the guns would assert a final and decided superiority over armour. Admirals Elliot and Ryder, in their separate report, expressed an opinion that the continued use of side armour was of doubtful expediency. They objected to the use of any vertical side-armour of less than twenty inches in thickness as a protection to the vitals of a ship. They believed that if war broke out, and our fleet were protected by this armour, the other maritime nations would resort to the use of guns, against which the armour we were then employing would afford no protection.

At the date when they wrote, the Elswick Company were making twelve 100-ton guns for the Italians, and the French had a 38-ton breech-loading gun, which, next to our own, was the most powerful gun in any navy. M. Dislère in his suggestive essay, recently published—*La Marine Cuirassée*—condemns as inadequate any armour of less than sixteen inches in thickness; and it has been laid down by the Right Hon. and gallant Member for Stamford (Sir John Hay) that a ship defended by sixteen-inch armour must have a displacement of 16,000 tons. In the opinion of M. Dislère, armour, if penetrable, is worse than useless; for if there be reason to hope that large shells may penetrate the thin sides of unarmoured ships with-

out bursting, it is certain that they will burst against the weakest armour. *Mr. T. Brassey.*

While the value of armour as a protection against guns is daily becoming more and more doubtful, it seems probable that engagements will hereafter be fought, not with the gun, but with the ram and the torpedo. In support of this statement I might multiply quotations from Commander Noel's able essay, *The Gun, the Ram, and the Torpedo;* from Captains Colomb and Pellew, from Admirals Touchard and Jurien de la Gravière, from M. Dislère and many other authorities. In dissenting from the report of the Committee on Naval Designs, Admirals Elliot and Ryder express their firm conviction that the most destructive means of attack will be found in the ram and the torpedo; that the most efficient ram will prove the most efficient fighting ship, and that the leading features of unsinkableness and handiness, which constitute the best ram, will also facilitate the avoidance of the enemy's torpedoes. Looking to the growing importance of ram and torpedo warfare, it appeared to them most desirable to avoid building ships of such large dimensions as the modified 'Fury,' with a displacement exceeding 10,000 tons. In the United States special attention has been devoted to torpedoes. Admiral Porter, in an official report, has predicted that in the next great naval fight the torpedo will decide the result. At Berlin it has been determined to build no more large ironclads at present. General Von Stosch, the head of the German Admiralty, stated in the Reichsrath last December, that the improvement in torpedoes rendered it undesirable to build the flotilla of monitors for coast-defence included in his former shipbuilding programme. In France it is believed that the torpedo is destined to produce in naval tactics a revolution not less complete than those which have been already brought about by steam, rifled guns, armour-plating, and the ram. The torpedo will now, M. Dislère predicts, be fired from the broadside of ships in action. It may, in short, be regarded as a submarine gun. During the Franco-Prussian war, the French fleet in the Baltic was reduced to complete inaction by the dread of torpedoes. Turning from foreign opinions, what do we learn from the most eminent authorities in our own country? Sir Spencer Robinson told the Committee on Designs that he believed a total change in naval warfare was impending; that what we wanted most was neither 'Devastations' nor 'Sultans,' but a class of immensely powerful torpedo ships. Torpedoes were destined to a great position in naval warfare. Here it may be asked whether the attention of the Constructor's Department has been sufficiently directed to torpedo

The torpedo. Its effect in naval warfare.

Mr. T. Brassey. vessels. We have completed one small vessel, the 'Vesuvius,' but a first experiment must inevitably suggest many improvements which could be advantageously introduced in subsequent designs. Mr. Barnaby has frankly admitted that it is a question how far we dare go on putting large sums of money into single ships, remembering that every ship in existence can be penetrated by torpedoes, the large ships as easily as the small ships.

Rams. Where such differences of opinion prevail, it is difficult to arrive at a conclusion as to the most judicious practical application of the Shipbuilding Vote. There is, however, a general concurrence of opinion in favour of certain types. Rams are admitted to be necessary, and the smaller the dimensions, having due regard to other conditions, the more formidable such a vessel must be. The power of a ram depends on speed and facility in turning. *Mobilitate viget, viresque acquirit eundo.* The steam ram should be protected by armour in vital points, and it is impossible to give armour protection to a small vessel without some sacrifice of other qualities. In vessels specially designed to act as rams it would be advisable to give up guns, and it would be unnecessary to insist on a large supply of fuel. The use of rams for harbour-defence has been fully discussed by M. Dislère. The ram for coast-defence must not, in his opinion, be diverted from its proper use. As Admiral Goldsborough has put it, 'The vessel must be the projectile, the steam-power the gunpowder.' The combined effect of the weight of the vessel and her speed cannot but be irresistible, and the ram, reduced to its one weapon the spur, relieved from the weight of the artillery and the armour-plating to protect it, rendered in consequence small, handy and swift, cannot but be a formidable adversary to a bombarding and blockading squadron, composed probably of ships greatly inferior in manœuvring qualities. I trust that the Admiralty may feel justified in ordering at least one ram to be built, free from the incumbrance of artillery.

Armour. Turning to seagoing types, the Committee on Naval Designs were unwilling to give up armour protection, even though the armour might be penetrable by the heaviest guns. They say:—'After making every allowance for the disadvantages that attend the use of an enormous deadweight of very costly armour, we cannot lose sight of the undisputable fact that, in an action between an armour-clad and an unarmoured ship (assuming that they carry guns of equal power), the former has, and must have, an immense advantage in being able to penetrate the sides of her adversary, at a distance at which she herself is impenetrable, and further, in

being able to use with effect those most destructive projectiles, common shells, which fall harmless from her own armoured sides.' *Mr. T. Brassey.*

'Audacious' class.

While it may be admitted that this argument seems conclusive in favour of the retention of armour for first-class vessels of war, all these advantages of the armoured over the unarmoured ship, on which the Committee chiefly insisted, are secured in the 'Audacious' class. The armour of these ships, which is eight inches thick at the most important points, will resist the projectiles of the 9-inch gun at 200 yards, and must therefore continue to be of service, until foreign vessels of war receive a more powerful armament than they usually carry at the present time. As cruising ironclads for general service, the 'Audacious' class—in which, for the purpose of comparison with other classes, the 'Swiftsure' should be included—presents the best result yet attained for an equal expenditure of money. The cost of each of these vessels may be put in round figures at 250,000*l.*; and it is stated by the constructors of the Admiralty, in their special report, that they have guns capable of penetrating all but the exceptional armour of foreign Powers, and that they carry armour impenetrable to all but the exceptional guns of such Powers. They carry their guns into action at a speed closely approaching to 14 knots, and they can cruise without the use of steam. Moreover—and this, perhaps, is the most important consideration of all—this result is attained in ships of a moderate size, and the first cost of the ships and of the men required to man them is thus kept down to the lowest point. All these advantages have been still more fully realised in the 'Shannon,' now building at Pembroke. When, therefore, we take into consideration that three 'Shannons' can be built for the cost of one 'Inflexible,' or at least that five 'Shannons' can be built for the cost of two 'Inflexibles,' it would appear wise to divide our expenditure more equally between the two classes. Instead of having only one 'Shannon' in progress, and two 'Inflexibles,' it would be more advantageous to the Navy that we should be now constructing four 'Shannons' and only one 'Inflexible.'

'Inflexible.'

The policy of building any vessels of the 'Inflexible' class is open to some doubt. None are being built in the United States, and only one—the 'Redoubtable,' very slowly—in France. In Russia the 'Peter the Great' is gradually approaching completion, having been commenced some four or five years ago. Yet in the present undecided state of naval opinion, and while other Powers continue to build such vessels, reluctantly following in the line on which we have been proceeding in England, and imitating a policy which their own constructors disapprove, the public might feel some uneasiness

Mr. T. Brassey.

if we were to abandon altogether the construction of first-class ironclads. Sir Spencer Robinson's evidence before the Committee on Designs is an accurate reflection of the naval mind on this question. He wanted more 'Devastations,' although he fully recognised their defects. He wanted more 'Sultans,' for services in which the ships would be required to remain at sea for a lengthened period. At the same time, he admitted that we were on the eve of a complete change in naval warfare; and that, when the torpedo system had become more perfect, large ironclads would not be necessary.

Effective ships may be produced of moderate tonnage.

If only the Admiralty will be firm in insisting on moderate tonnage in future designs, we may rest confident that it will be found possible to produce most formidable vessels at a greatly reduced cost. The triumphs of the Hon. Member for Pembroke (Mr. E. J. Reed) were won by combining greater fighting power with smaller dimensions than those adopted in the earlier ironclads. The 'Hercules' surpasses the 'Minotaur' even more in the superior facility with which she can be manœuvred, than in the weight of her armour and the power of her guns. The ingenuity of our naval architects would be turned to good account in designing the most powerful ships that could be built for a sum not exceeding 100,000*l.* The true policy of naval construction has been well described by M. Gervaise, an eminent constructor of the French Navy.

Our aim should be, not simply to produce ships more powerful and of greater speed than others of known form and dimensions. That object may generally be attained without difficulty, simply by building a larger ship than the type you wish to surpass. The really difficult problem is to produce a ship which shall combine the required power and speed with the smallest dimensions. In other words, the merit of naval architecture consists in producing the greatest possible amount of naval force for a given sum of money. These are principles which cannot be too strongly insisted upon, and which the British Admiralty have so often forgotten in the sacrifices they have made to the idol of popularity. In justice to our own constructors, we must add that they have consistently expressed the same opinions. In their report on the 'Audacious' class to the Committee on Designs they say:—

'In view of the dangers to which ships, however heavily armoured and armed, and however large, are exposed from torpedoes, rams, and other submarine attacks, we consider the best ships are those of the smallest dimensions which can engage the armour-clad frigates of other nations with a good prospect of success.'

The advice thus tendered to the Admiralty should be appreciated

by Parliament. The Constructors have manifested an evident reluctance to expend the ample resources at their disposal in building sensational ships. These things are done to please the public; and public opinion on such a question rests on imperfect knowledge. The judgment of the Department itself is the judgment of men of special knowledge, whose claims to our confidence rest on close and constant study of this complicated question in all its bearings. *Mr. T. Brassey.*

In conclusion, I would suggest one other argument against building ships of exaggerated size. Will not a captain be burdened with an almost intolerable anxiety, when he knows that his ship is one of a very limited number, and that the loss of such a ship may be a serious blow to the Navy? In the numerous fleets of the olden times, the fate of an individual ship was a less momentous question. But if you concentrate the whole powers of the Navy in a few ships, such as we have lately built, you throw upon the officers in command an intolerable weight of responsibility. You will restrain and chill that gallant and almost reckless ardour with which the great battles of the past were fought and won. Responsibility of commanders of large ironclads.

Navy Estimates; H.M.S. 'Inflexible.'

Mr. T. Brassey wished briefly to refer to the opinions of eminent foreign authorities. A careful review of the arguments advanced by the most competent naval officers abroad showed clearly that it was desirable that our armour-clad ships should be for the most part of smaller dimensions than those already built. For many years past there had been so great a difference of professional opinion on the subject, that it might be very profitable to compare the conflicting utterances of foreign naval writers with a view to forming an opinion for ourselves. He would refer in the first place to the French constructors, who were second to none in talent and originality. So long ago as 1873 M. Dislère, an able member of the staff of Constructors in the French service, had expressed an opinion that armour-plating was obsolete for sea-going cruisers. M. Dislère thought that enough attention was not paid to the new weapons, the ram and the torpedo, against which the colossal ironclad must engage at a serious disadvantage. The means of resisting the attack by torpedoes were in his opinion not yet devised, and he advocated a greater distribution of the risks of naval warfare by reducing the dimensions and displacements of battle ships. Admiral Jurien de la Gravière, another great French authority, believed that in future Hansard, June 18, 1877. Opinions in favour of moderate dimensions. *M. Dislère.* *Jurien de la Gravière.*

Jurien de la Gravière.

ships would fight with the ram alone, and that naval battles between ironclads would be like the ancient tournaments. Fleets would rush forward to the charge, pass through each other, and then turn and renew the attack. In these evolutions the slowest vessels would offer their broadsides to their assailants, and run the risk of being destroyed by ramming. At the close of the War of Secession in America the most distinguished officers were invited to convey to the Naval Department the conclusions to which they had been led by their recent experiences in active warfare. He would most particularly refer to the report of Admiral Goldsborough. That gallant officer stated that in his opinion the ram was the most effective weapon, but success depended entirely upon the 'handiness' of the attacking vessel. Where it was intended to rely on the ram, it was necessary to limit the displacement and the length of our ships. The Austrian officers who fought at Lissa, where the ram was used with triumphant effect, were all agreed that the ram must be an irresistible weapon if wielded with skill and unflinching courage. The Chief of the Austrian Constructors' Department had called it 'the bayonet of naval warfare.' Turning to our own professional advisers, the Chief Constructor of the Navy, Mr. Barnaby, had lately read a paper at the Institution of Naval Architects, in which he showed that auxiliary squadrons of rams and torpedo-vessels afforded the best means of defending our large ironclads against attack from similar weapons. This paper was received with the highest favour. Sir Spencer Robinson said that no more valuable suggestion had ever been made in his experience. He regretted that the First Lord had not framed his programme of shipbuilding in accordance with these views.

Admiral Goldsborough, U.S.N.

Mr. Barnaby.

Armour.

The controversy as to the continued use of side-armour must naturally arouse the greatest anxiety in the country. It was said that unless armour be strong enough to keep out shells, it was worse than useless; and armour, more or less impenetrable, even when limited to vital places, involved a large addition to the cost, and an increase of dimensions, tending to diminish that mobility which was of the last importance, if, as Admiral Jurien de la Gravière predicted, ships will fight in the future with the rams alone. In our Navy there was an almost hopeless conflict of opinion. Captain Noel insisted that excessive top-weight should be avoided. On the other hand he was assured, in an able letter from an Admiral in a high command, that our men would have no chance if they had to contend with heavy guns protected by a turret, and therefore fired with confidence and precision. The painful uncertainty in which we were placed in this

Captain Noel, R.N.

country was shared by every maritime Power. In Russia, attention was being directed chiefly to the circular ironclads, the 'Popoffkas,' which were intended solely for coast-defence. In Germany, it had been decided to lay down no more ironclads at present. The 'Inflexible,' which had just been launched, was protected by 18-inch armour, and the 'Dandolo' by 12-inch armour. When the progress of gunnery had rendered 22-inch armour insufficient, Messrs. Cammell undertake to roll plates of 30 or even 40 inches. *Captain Noel, R.N.* — Russian Navy.

For the moment, as it was observed in the *Times* report, the advantages seemed to be in favour of armour; and yet a target, representing the strongest portion of the armour of the 'Inflexible,' was penetrated a few months ago at 1,800 metres by a Krupp gun. While, however, we found an eminent French authority announcing that armour would shortly be laid aside, in his annual report, published last December, Admiral Porter said that the aim of the United States should be, in making changes, to resist the shot from the 12-inch 35-ton, which at 200 yards perforated 15 inches of solid wrought iron. He asked for 24 first-class ships; but such vessels will represent, in his opinion, no decided power for offence and defence, unless they carried sufficient thickness of armour to resist the average rifled gun, and had speed to get within striking distance of the enemy. Wooden vessels added nothing to the fighting force, just as, in former days, engagements fought with frigates never materially affected the result of a war. For fighting purposes he preferred a turreted vessel to any other. *Admiral Porter, U.S.N.*

Where such differences prevailed as to the efficiency of armour-protection, and while it was obviously impossible to establish a conclusion without the lessons of experience, he would urge that a large proportion of the money voted should in future be given to the weapons of attack, of the efficiency of which there could be no doubt, and a smaller proportion to the means of defence, the success of which was so extremely doubtful.

Navy; Designs of Ships for War.

In seconding the motion of the Hon. Member for Lincoln (Mr. Seely), I wish to explain that, while I give my hearty support to his proposal, I see no cause for general dissatisfaction with our Navy. The zeal and ability displayed throughout the recent crisis of preparation for war, in the fleet, at the Admiralty, and the dockyards, have disarmed criticism. But though I gladly acknowledge that *Mr. T. Brassey.* March 11, 1878.

Mr. T. Brassey.

Proposal for the appointment of a Committee on Designs.

we possess a fleet in which the country may justly take a pride, I venture to think that, with more consideration and forethought in our naval administration, we might have done better. I confidently believe that a searching parliamentary inquiry at the present juncture would be of great assistance in framing a policy for the shipbuilding of the immediate future.

Deficiency of the Navy in coast-service vessels.

I need not enter on a long review of our past naval history, in order to show that such an inquiry is desirable. In former times our ships were generally good in workmanship, though often obsolete in design. Our later ships, though admirable examples of naval architecture in their several types, are almost exclusively adapted for ocean warfare. No one will complain that we have too many first-class ships, but we have no in-shore squadron worthy of the name. We have been warned of our shortcomings in this respect by Sir Thomas Symonds and the other eminent officers, but we have neglected their advice.

Excessive cost of ships.

Our shipbuilding policy is open to criticism on another ground. All our recent ships have been of the largest dimensions, and, as an inevitable consequence, the additions to the fleet have been lamentably few. In the five years ending March 31, 1879, only seven ironclads will have been added to the Navy, and five only will have been built in Her Majesty's Dockyards. The cost of our ironclads has advanced in proportion to their tonnage. The 'Inflexible' is estimated to cost 460,000*l.* It seems a strange fatality that the design for our largest and costliest ship should have given rise to a controversy of unprecedented warmth. I shall not enter now upon a discussion which will more properly be raised on the motion of the noble Lord the Member for Chichester. It may be questioned whether the increase in fighting power is proportionate to the increase in the cost of the later ships. In comparing the 'Dreadnought' with the 'Devastation' M. Dislère, the eminent French naval constructor, observes that, in order to secure a slight increase in armour and armament, the displacement has been enlarged from 9,190 to 10,900 tons, an augmentation of 1,710 tons, involving an addition of 80,000*l.* to the cost, and an addition of 33 feet to the length. 'How,' he asks, 'will such enormous masses be manœuvred in the confusion of a naval engagement? How will the ram, the most effective weapon, be used to the best advantage?' These are questions on which the battle of the future may teach some unexpected lessons. I might quote opinions to the same effect from the separate report of Admirals Elliot and Ryder as members of the Committee on Designs for ships of war, and from many other officers. There is

reason to fear that our shipbuilding policy is conceived too much under the influence of a spirit of international rivalry. In a country in which the action of the Government is mainly guided by public opinion, professional judgment is too readily surrendered to popular ideas. Sensational ships are built to gratify the public; and the popular view of these subjects is derived from experimental firing at targets or from trials over the measured mile, and not from any experience or conception of the practical conditions of naval warfare. *Mr. T. Brassey.*

Observations on armament.

The same tendency to the sensational, which is observable in the designs for ships, is exhibited in their armament. When it is remembered how small a percentage of shot can possibly take effect, when the combatants are moving at high speed, it becomes a question how far we ought to go in the introduction of 80-ton or even 38-ton guns, as the principal, in some cases the only, armament of our ships. The increase in calibre involves not only a reduction in the number of guns, but a reduction in the rate of firing, which may prove a serious disadvantage in a naval action. The Committee on Designs recommended the general adoption of a composite armament of protected and unprotected guns. This valuable suggestion has not received sufficient attention. Speaking generally, the armament of the most recent ships is not proportionate to their tonnage; the offensive power has been unduly sacrificed to the defensive, the gun to the armour. In a speech at the United Service Institution on March 30, 1870, Captain Dawson said:—

'In all the later ironclads there has been a continual diminution in the offensive power of the armament. We have an instance in the "Devastation," a ship of 9,000 tons, carrying only 140 tons of ordnance. That is a very limited offensive power for any first-class ironclad. The 140 tons are divided into four untried pieces. If anything happens to any one of these four untried pieces one quarter of the armament will be lost.'

Captain Dawson considered that the chances of hitting a target were as one in ten, and that in a naval engagement a yet smaller proportion of shots would take effect. The 'Inflexible,' of 11,000 tons, carries only 320 tons of ordnance. Would not such a ship be more fitted for naval warfare by the substitution of 200 tons of ordnance for an equal weight of armour? The 'Nelson' and 'Northampton,' of 7,460 tons, carry four 18-ton guns and eight 12-ton guns. M. Dislère speaks favourably of the designs of these ships, but considers that the guns should be of heavier calibre. An 18-ton gun is not powerful enough for an engagement with a first-class ironclad. On the other hand, he considers the displacement of 7,440 tons is too large for ships

Mr. T. Brassey.

intended only for the protection of commerce. The same observations are equally applicable to our largest unarmoured ships. The 'Shah' has only two guns capable of penetrating the four-inch armour of the 'Huascar.' In a recent lecture at the Royal Engineers' Institute at Chatham, Captain Bridge has pointed out that a strong fortress can only be reduced by a continuous bombardment from a large number of guns. He reminds us that when the Federal fleet attacked Fort Fisher, in the harbour of Wilmington, on the 13th, 14th, and 15th of January, 1864, over 50,000 shells were fired from the ships. If the fleet which we have stationed in the Sea of Marmora had been required to engage the shore-batteries in the Dardanelles or the Bosphorus, the deficiency of the squadron under Admiral Hornby, in regard to the number of the guns, would have made itself felt.

Remarks on the fleet in the Sea of Marmora.

Our shipbuilding policy may be tested in the most practical way by examining the composition of the fleet under Admiral Hornby, with reference to the service in which it has recently been employed. Such a comparison will, I venture to say, afford the most conclusive proof of the necessity for adding to our existing naval force the smaller classes of fighting vessels. While the splendid ships assembled under Admiral Hornby possess unquestionably great power for battle, they were mostly designed for ocean warfare rather than for inland service. A deep draught of not less than twenty-six to twenty-seven feet is a serious drawback when operating in shore. The Royal Commission on our coast defences laid it down that the maximum draught of a coast-defence vessel should not exceed fifteen feet. How many ironclads do we possess drawing less than fifteen feet? The coast-defence vessels, while less costly than the large ships, would have been better adapted to the practical exigencies of the naval service in the Mediterranean, the Red Sea, the Straits of Singapore and in other confined waters, where we have great interests at stake. We were conspicuously deficient in ships adapted for attacks on ports and batteries. It was for naval operations on the coast that the Americans invented the 'Monitor.' For 55,000*l.* Mr. Ericsson undertook in the space of 100 days to construct an unarmoured shot-proof coast-defence vessel, displacing 1,200 tons, drawing ten feet of water, and capable of going nine knots an hour. If such an achievement was possible in the United States in 1864, it encourages us to believe that the mechanical resources of the United Kingdom in 1878 would be capable of promptly creating a most powerful flotilla. I trust, however, that we shall not be betrayed, in reliance on our latent resources, into a policy of procrastination. Vessels, even small vessels, hurriedly constructed, must be imperfect in many ways; and

Draught of water for coast-service vessels.

Ericsson's 'Monitor.'

hasty preparations for war, at a time when our foreign relations are becoming constrained and difficult, are necessarily irritating. No navy has had so much experience of coast warfare since the introduction of armour as the American. Their officers are unanimous in their approval of the 'Monitor' for engaging batteries. The type combines in the highest attainable degree the two qualities which Vice-Admiral Touchard considers most essential in a coast-defence vessel—namely, a maximum of invulnerability and a maximum of armament. Of the thirty monitors which the United States had afloat during the war, only one was destroyed by the fire of the enemy. The monitor, or armoured gunboat, is being rapidly introduced in European navies. The Germans have constructed two monitors, and five armoured gunboats of 900 tons displacement, protected by 4-inch armour, and carrying one large gun. Of the twenty-seven ironclads in the Russian Navy, twenty-two are designed for coast-defence; seven draw from nineteen to seventeen feet, one fourteen feet, and thirteen draw eleven feet and under. The latter are exact reproductions of the American types. The French have thirty-five ironclads afloat, and sixteen in construction. Of their fifty-one ironclads nineteen are coast-defenders. Six of the latter, which are now in construction, are of great power.

Mr. T. Brassey.

German, Russian, and French coast-service vessels

Another deficiency may be pointed out in our Mediterranean fleet. Our large ships are unsupported by a supplemental force of steam rams and torpedo-vessels. It is not necessary to insist on the offensive power of the torpedo. The House was sufficiently alarmed by the stirring speech of the noble and gallant Member for Waterford (Lord Charles Beresford), whose devotion to his profession we must all admire. It must be obvious to those least familiar with naval matters that it would be extremely difficult for an ironclad, armed with a limited number of heavy guns, to repel the simultaneous attack of numerous torpedo-boats steaming twenty knots, and manned by determined men. Several boats might be destroyed, but others would succeed, under cover of the smoke, in striking a fatal blow. In the session of 1876, at the Institute of Naval Architects, Mr. Barnaby acknowledged the vulnerability of our largest and most powerful ironclads, if attacked with the ram and torpedo; and he pointed out, with the concurrence of Sir Spencer Robinson, that the strongest defence against such an attack was by a counter attack with similar vessels grouped around the large ships. Admiral Porter, in his annual report to the Secretary of the United States Navy, has returned again and again to this subject. In the year 1874 he asked for fifty iron torpedo-boats, of a moderate speed, and

Torpedo flotilla.

Mr. T. Brassey.

of not less than 100 tons each. He has since recommended that, besides several small torpedo-boats built for coast-defence, six of little more than 1,000 tons should be constructed of iron for foreign service. The Americans have lately built a torpedo-vessel, the 'Alarm,' of 100 feet in length, twenty-eight feet in beam, and ten feet draught, which carries one heavy gun, eight Gatlings, and a complete torpedo gear. The programme for the German Navy provides for twenty-eight torpedo vessels, which are to be completed in the year 1882. Admiral Porter considers that those twenty-eight torpedo-vessels will make the eleven ironclads which Germany already possesses a match for an equal number of ironclads of twice the size, without torpedo-boats. Torpedo-boats might be carried for the fleet in special vessels. Boats of this description have become a necessary part of the equipment of a fighting ship. In the German Navy, the 'Sachsen' class of armoured corvettes, of which there are to be five, with a displacement of 7,300 tons, carry torpedo-boats of large size. The 'Duilio' is fitted with special appliances for launching torpedo-boats in a seaway. The estimates which have been laid before us provide for the construction of twenty-eight torpedo-boats in 1878-9. The number is greatly inferior to the flotilla which, according to common rumour, was lately being prepared for the Russian Navy.

Steam rams.

Armoured vessels, possessing in a high degree the manœuvring qualities which are essential in the ram, are another indispensable adjunct to a fleet of larger vessels. It was stated by the late lamented First Lord of the Admiralty (Mr. Hunt), in moving the estimates of last year, that it was in contemplation to build a ram on the plans of Sir George Sartorius. I regret that no progress has been made in carrying out that intention; the Hon. Member for Pembroke (Mr. E. J. Reed) has publicly stated that, in his opinion, before armour is superseded as a defence against guns, guns will be superseded as a means of attack, and the ship itself, viewed as a steam projectile, will be deemed the most formidable weapon. In the essay for which the gold medal of the United Service Institution was awarded, Captain Noel proposed that a group of three vessels should constitute the tactical unit of the fleet. The group should consist of one third-class ironclad and two armoured rams of about 2,500 tons each. Our costliest and most heavily armoured ships are too large to be manœuvred as rams, and too costly to be risked in such an uncertain and hazardous mode of warfare. Rams and torpedo-boats would have cost a mere fraction of the sums expended on the large ships, around which they ought at this

moment to have been grouped in the narrow waters of the Sea of Marmora.

Mr. T. Brassey.

Special types required for the various operations of naval warfare.

Our constructors seem to lack the courage of their opinions. Accepting the necessity of limitation in size they must build special vessels for each arm of the navy. It has been said by Captain Colomb that we have no ship in our navy in which the principle of building special vessels for special services has been satisfactorily embodied; we have no ship in which the gun power has been properly sacrificed to assist the ram, or the ram power judiciously curtailed to admit of increased ordnance. The general policy which should guide our naval construction was well described by Sir Spencer Robinson when he said:—

'A fleet must be composed of ships of various classes. No single ship will be adapted for naval warfare with the means of destruction which now exist. Every ship must act in combination with other ships; she must be the unit around which other ships congregate, and when we have got the ship and her satellites in attendance upon her of the right size, sort, and stamp, then we have got the one unit of force capable of doing its duty in what may be called single action, and the concentration of these ships and their attendant satellites will constitute a fleet.'

The same views were expressed by Captain Vansittart in his Report to the Admiral in command of the Channel Fleet in 1868. He said:—

'I recommend the construction of a certain number of turret ships, capable of mounting far heavier guns than any known in the late squadron, beside some few armoured rams, simply as rams, not with the idea of substituting turrets for broadsides, but with the view of strengthening England's fleets. In short, I would adopt the old saying of not putting all our eggs into one basket.'

In the shipbuilding programme of the future, I hope to see the principle of special classification more distinctly recognised; this was the policy so strongly recommended by the Committee on Designs. As a powerful armament, thick armour, speed, and light draught, cannot be combined in one ship; although all are needed for the defence of the country, there is no alternative but to give the preponderance to each in its turn, amongst the different classes of ships which shall mutually supplement each other. The first-class battle-ships of the future will doubtless be constructed after the type of the 'Devastation.' The large ships, again, must be supported by armoured rams, torpedo-vessels, and torpedo-boats.

LETTERS, SPEECHES, AND PAPERS BY THE COMPILER.

THE COMPILER'S LETTERS TO THE 'TIMES.'

IRONCLADS AND RAMS.

Sir T. Brassey.

Times, Sept. 22, 1875.

SIR,—In the last Session I called the attention of the House of Commons to the shipbuilding policy of the Navy, and endeavoured to point out the grave consequences which must follow if we continued to build ships of the vast and ever-increasing dimensions of our last ironclads.

Limitations on the use of armour.

The enormous size is rendered necessary by the thickness of the armour, and the stoutest armour will be perforated by the guns now being constructed for the naval service. But the ram and the torpedo are far more formidable than the heaviest ordnance, and superior speed and handiness—the *faculté giratoire* of the French writers—afford the only protection against these dreaded weapons.

These views have been consistently supported in the columns of the *Times*, and you are wisely inviting public attention to the subject in connection with the recent disaster in the Reserve Squadron.

It is not the entire abandonment of armour, but the limitation of its use that is here contended for. It may be retained on coast-defence ships. On the other hand, in ships of high freeboard, intended for ocean cruising, where the surface to be protected is of necessity considerable, it seems impracticable to apply armour of sufficient thickness to resist the fire of modern naval artillery, without an extravagant increase both of cost and dimensions.

Among the special vessels, for which armour protection can be retained with the greatest advantage, I venture to suggest a class of ships designed to act solely as rams.

If any proof were needed, the loss of the 'Vanguard' has proved

the fatal power of the steam ram. It must now be assumed that efficiency as a ram is an essential quality in all ships intended to engage an enemy in line of battle. The efficiency of a steam ram depends on its mobility; and *cæteris paribus*, mobility will be increased as the dimensions are reduced. It is self-evident that a short ship will turn more quickly and in a smaller circle than a long ship. The probability that the ram will play a decisive part in the naval battles of the future furnishes a conclusive argument against extreme tonnage. *Sir T. Brassey.*

A steam ram of novel type has been proposed by experienced naval officers in France and the United States. Armour protection is retained in vital points; but, as it is impossible to give sufficient armour protection to a vessel of small size without sacrificing some defensive or offensive qualities, it is considered advisable to give up the guns. If rams were constructed on this system, the vessel, to use the appropriate comparison of Admiral Goldsborough, must be the projectile, the steam power the gunpowder.

Rams and torpedo-boats.

In the last report addressed to the Secretary of the United States Navy by Admiral Porter, Congress is advised not to build monster ironclads with a high freeboard protected by thick plating—a task, be it observed, which has never been attempted by the naval constructors of the American service. Admiral Porter believes that rams and torpedo-vessels are more likely to be useful in naval war, and he accordingly recommends his Government to build thirty powerful rams of great speed, and at least fifty iron torpedo-boats, of good speed, and not less than 100 tons. The frequent failure of submarine mines has convinced naval men in the United States that the best form of offensive torpedo is a torpedo-vessel fitted with an outrigger.

Effects of smoke in action.

A passage in the report of the American Admiral reminds us that in one important particular a naval action would probably be fought in circumstances similar to those which led to the destruction of the 'Vanguard' by the 'Iron Duke.' Just as a dense fog in the Irish Channel caused a fatal collision between two friendly ships, so it will be in a naval battle. Landsmen and civilians, who have been present at the naval displays at Spithead, will remember how speedily the splendid spectacle was obscured from view by the comparatively insignificant explosion of a Royal salute. In a naval battle the ships will be enveloped in a cloud of impenetrable density, and it is evident, as Admiral Porter points out, that 'rams and torpedoes will have pretty much their own way then, and the more smoke there is the better it will be for them.'

Sir T. Brassey.

It would only be by continual and rapid movement that large ships could avoid the attacks of rams and torpedo-vessels, and, where all depends on facility of evolution, it is scarcely politic to construct ships, like the 'Inflexible,' of 11,000 tons.

Naval construction in Germany.

These are considerations which have been duly appreciated by the naval administrations of other countries. In recent years Germany alone has followed in our wake in the construction of a fleet of high freeboard, masted ironclads. The Germans have eleven ships of this class and twenty-eight torpedo-vessels. The construction of large armoured vessels is not at present being pushed forward with much vigour, and, although a programme has been laid down for additional ships, we may rest assured that there will be no hesitation in modifying the plan proposed from time to time, in conformity with the lessons derived from practical experience. The French constructors have designed a vessel, which is to rival the 'Inflexible,' but the progress hitherto made is not more rapid than that attained in the case of the 'Peter the Great.'

Arguments for moderate dimensions.

A survey of the proceedings of foreign constructors fails to establish the necessity for spending large sums on monster ironclads for the English Navy. Does not an examination of the actual and prospective conditions of naval warfare point to a very different policy? Would not the ingenuity of our naval architects be most fitly exercised in the construction of swift, handy, and unsinkable rams?

Mr. Reed won for himself deserved honour by bold innovations, in which the most conspicuous merits were reduction of length, and consequent increase in weight of armour, combined with improved steering qualities. If he could devote some portion of the Parliamentary recess to improving the designs of ships of war, and would once more lead the way in the development of naval architecture in the same direction in which he has already been the pioneer of his profession, he will be doing a service to the Navy for which his fellow-countrymen will be grateful.

The recent catastrophe in the Irish Channel is a striking illustration of the risk we run from concentrating our naval power on a small number of large ships. In the numerous fleets of olden times the loss of an individual ship was not an overwhelming disaster. The case would be very different in a fleet composed of four 'Inflexibles,' which had cost as much as twenty line-of-battle ships such as Lord Nelson commanded.

M. Gervaise.

I shall conclude this too voluminous communication by quoting some observations made by M. Gervaise, an eminent constructor of

the French Navy, quoted by M. Dislère in his recently published work, *La Marine Cuirassée*:— *Sir T. Brassey.*

'Our aim should be, not simply to produce a ship more powerful and of greater speed than another of known form and dimensions. That object may generally be attained without difficulty simply by building a ship of larger dimensions than those of the type you wish to surpass. The really difficult problem is to produce a ship which shall combine the required power and speed with the smallest dimensions. In other words, the merit of the naval architect consists in producing the greatest possible amount of naval force for a given sum of money. These are principles which cannot be too strongly insisted upon, and which the English Admiralty has forgotten so often in the sacrifices it has made to the idol of popularity.'

The most powerful ships, as the recent collision has shown, are not less vulnerable than the smallest, when struck by the ram or torpedo. For naval warfare, under present conditions, distribution rather then concentration of force should be the aim of those who design our ships.

I have the honour to be, Sir,

Your obedient servant,

THOMAS BRASSEY.

Observations of the 'Times' on the preceding Letter.

We publish to-day a useful contribution to the literature on the subject, in the form of a letter from Mr. Brassey. He is half a sailor himself, and by his attention to naval matters, in and out of Parliament, won a right to a hearing on the question. He agrees with us in deprecating the continued construction of ironclad cruisers, and contends that armour-plating should be confined to special ships, built for special purposes. He quotes from the last Report addressed to the Secretary of the United States Navy by Admiral Porter,—an officer who has had experience in actual ironclad warfare, which our Admirals have not had the luck to enjoy,—in which Congress is advised not to build monster ironclads with a high freeboard protected by armour-plating, but 'to build thirty powerful rams of great speed, and at least fifty iron torpedo-boats of good speed and not less than 100 tons each.' Mr. Brassey reminds us that a Royal salute at Spithead is sufficient to obscure from view the squadrons of a Naval Review, and that a naval battle, with its accompaniment of smoke, will resemble the fog in which the 'Vanguard' was destroyed. *Times, September 22, 1875.*

Times. In such an atmosphere, as Admiral Porter points out, 'rams and torpedoes will have pretty much their own way, and the more smoke there is the better it will be for them.' Some of our readers will have noticed the account given in our impression of Thursday last of the steam torpedo-launch just built on the Thames for the Government of Austria. The frequent failure of submarine mines has shown that the best form of offensive torpedo is a torpedo-vessel fitted with an outrigger, to which the torpedo is attached. The new launch is only 67 feet long, with a beam of 8½ feet, and carries an outrigger on either side 38 feet long, and is stated to have steamed in the hour upwards of 18 knots. A vessel like this, moving at the speed of a railway train, and by its small size difficult to hit—at any rate, in smoke or fog—might steam past any of our ironclads and deliver the fatal torpedo with the same disastrous effect as the blow of the 'Iron Duke's' ram. Still more might rams like our 'Rupert,' and the 'Taureau,' 'Bélier,' 'Boule-Dogue,' 'Cerbère,' and 'Tigre' of the French Navy, with a speed of 13 knots and armour-plating 12 inches thick, commit havoc in a fleet of broadside ironclads of the existing type. Unless ships can be constructed less 'sinkable' than our present men-of-war, it seems a waste of power to continue the construction of fleets designed to meet in line of battle.

It is, therefore, of importance at the present time to call attention to the Report and Recommendations of the Committee of Naval Design of 1871, in which a body of professional and scientific men, expressly consulted by the Admiralty, directed the attention of the Government to this very point of the 'sinkability' of our ships, the ignoring of which has been so lately signalised by the 'Vanguard's' loss. The committee were unanimous in regarding the 'Devastation' class as 'representing in its broad features the first-class fighting ship of the immediate future.' They were divided in opinion as to the policy of continuing to build ships like the 'Hercules' or 'Vanguard.' Some were for abandoning them altogether; a few, and they connected with the Admiralty, were for adhering to the 'Hercules' type; while a majority, in spite of much adverse evidence, were in favour of building, for the present, second-class ironclad cruisers resembling the ill-fated 'Vanguard.' But the matter of chief moment, both in the examination of witnesses and in the recommendations of the Committee, was the importance of providing some new system of giving buoyancy to our ironclads when struck below the water-line by any of the projectiles of naval warfare. Devise some method of making the ship 'unsinkable' by moderate wounds, and improved vessels of the type of the 'Volage' or 'In-

constant' may play their part in a naval action. The 'Inconstant,' armed with the guns for which she was designed, may engage with prudence a vessel like the 'Hercules' or 'Monarch'; her vitals will be protected against their shot, and her projectiles will harm their crews more than her crew can be harmed by theirs. Give us this invention, and we shall be able to divide our Navy into three or four principal classes. We shall have ocean cruisers, without side-armour, for general service in peace or war; special ships for breaking into an enemy's ports, or meeting his men-of-war in line of battle; vessels of light draught for the protection of our coasts and the attack of the coasts of the enemy; while rams and torpedo-vessels will be the cavalry of the fleet, and deliver their charges when the line is broken. We trust it will not be necessary to press again and again upon the Admiralty the importance of experiments in this direction. It is of no use to perfect the science of attack if the science of defence is not equally developed. If we build our ships incapable of resisting submarine attack, ought we to desire our naval commanders to encounter an enemy well provided with torpedo-boats and rams? Yet how should we brook to see our ironclad fleets shunning an action, and to learn that from want of foresight in our rulers we were no longer masters of the sea? If we desire to avoid so humiliating an experience, we must take a lesson from the 'Vanguard's' loss. The lesson is open to all who can read, and they who read it quickest will be the best prepared for the next maritime war. *Times.*

SHIPBUILDING FOR THE NAVY.

SIR,—In commenting on Mr. Reed's interesting description of the 'Popoffka,' you rightly insist on the difficulty of designing ships of war in an age of perpetual innovation both in gunnery and naval architecture. There is, perhaps, only one essential point on which unanimity prevails. By universal consent an advantage in point of numbers is more important now than at any former epoch in naval history. *Sir T. Brassey.* — *Times,* Nov. 9, 1875.

Torpedo warfare is being brought rapidly to fatal perfection. The capability of the ram for striking an irresistible blow has been established by a recent melancholy and decisive experiment. In the power of resistance to such weapons as these the most heavily armoured ship has no proportionate advantage over an unarmoured vessel. It cannot, therefore, be wise to concentrate our strength on a few ships of extreme dimensions, which, however great their

Sir T. Brassey.

individual power, are exposed to the risk of instant annihilation. I observe with surprise and regret that the Admiralty still adhere to the contrary view. It has recently been announced in the *Times* that a new ship similar to the 'Inflexible' is about to be laid down at Chatham.

Arguments for building small vessels.

If it were certain, or even probable, that the enemy to be encountered would be armed with no other weapon than the naval gun, it might be worth while to make a large sacrifice of numbers, in order to secure a superiority in armament and armour. But no such assumption can be admitted. The highest authorities in foreign navies have distinctly declared that they will rely in the future on the ram and the torpedo rather than the gun. The Germans have decided to lay down no more ironclads at present, and to construct a flotilla of vessels particularly adapted to the use of the torpedo. We have one vessel only of the same class, the 'Vesuvius,' which is still under trial at Portsmouth. Every effort should be made to develope the strength of the Navy in torpedo-vessels capable of keeping the sea without the protection of a convoy.

Torpedo-boats.

All the principal Naval Powers are striving to improve the submarine torpedo, and rapid progress is being made. Pending the completion of a more elaborate weapon, a simpler plan has been provisionally adopted in the United States Navy. The torpedo is fixed at the extremity of a pole 40 feet long, and explodes on contact. We have a similar equipment in our own fleet. It is obvious that such a weapon can be used with greater effect from a small and swift steam launch than from a large ship. The construction of boats for this service is a necessity of the Navy.

The 'Minotaur' class have been criticised for the insufficiency of their armour and their unwieldy dimensions; but they would become most formidable if they were supplied with torpedo-boats, which they could carry in larger numbers than it would be possible to stow on shorter ships.

Rams.

In a former letter I quoted opinions and stated arguments in favour of the construction of certain vessels, without guns, designed to be used solely as rams. The attempt to build a vessel heavily armoured and armed, with a full spread of canvas, with great speed under steam, and fitted for use as a ram, must necessarily result in a costly and unsatisfactory compromise.

As a nation we delight in horses, and we thoroughly understand them. Long experience has taught us the necessity of various breeds for different uses, and we have at length succeeded in producing animals perfect in their several kinds, for the brewer's dray and the

pony cart, for Rotten Row or the hunting field. We should pursue an analogous course in building ships for the Navy. *Sir T. Brassey.*

For a vessel specially designed for use as a ram, what is the essential quality? It is unquestionably mobility, including in the term not merely speed but facility in turning. In order to secure the latter quality in the highest degree we must build short ships. I would suggest that the limit of size should be fixed at 1,000 tons, and as it is desirable that steam rams should be armoured on the bows, it is impossible to carry in addition a powerful armament. The importance of numbers has been already urged. It may be illustrated in connection with our present subject. Let us realise to ourselves what would be the situation of a ship of the 'Inflexible' class, of 11,000 tons, if exposed to a simultaneous attack by ten steam rams. In the facility with which they could be manœuvred the smaller vessels would have a great advantage; and, if they were as skilfully and fearlessly handled, as we have reason to believe they would be, by officers of the British Navy, the issue of the contest must be fatal to the single monster ship.

It may seem unfair to assume such a preponderating numerical superiority for the smaller vessels. But the case has not been overstated. I believe that the rams proposed could be built for a sum not exceeding 50,000*l.* each. Ten could accordingly be constructed for the cost of one 'Inflexible.'

Mr. Reed has set forth, with his usual clearness and ability, the distinctive merits of the circular ironclads of the Russian Navy. The Admiralty ought to test the efficiency of vessels of this type by building one for our own Navy. The public would not be dissatisfied if Mr. Reed were invited to furnish the designs.

Competitive designs should be obtained.

At all times, and particularly during a period of rapid transition, the Admiralty should avail themselves freely of all the inventive talent in the country, whether it be found within or without the official pale. When entire dependence is placed on a single mind, there must be a tendency to repetition. M. Dupuy de Lôme has done more than any other naval architect in the application of armour to the protection of ships. But with all his invention and ingenuity there is a certain monotony in his designs. It will be remembered that Mr. Reed was elevated *per saltum* to the office of Constructor, in defiance of established precedent. The inventions of Captain Cowper Coles are another example of the valuable ideas the Admiralty may derive from external sources. On the outbreak of the Civil War, Mr. Ericsson came to the rescue of the United States Navy, and produced in the 'Monitor' type the special vessels

Sir T. Brassey. which were wanted for attacking harbour defences, and for operations in the Mississippi.

At the present time all naval administrators are perplexed. I have ventured to recommend torpedo-boats, sea-going torpedo-vessels, and rams. But there is no agreement among professional men as to the best type of line-of-battle ship for the future. The Admiralty will do well to adopt your own suggestion, and invite the co-operation of our most experienced builders and naval architects. They should be asked to prepare designs for the most powerful vessel they can undertake to build for a sum not exceeding 100,000*l.* It should not be required that the gun and the ram or the finest sailing and steaming qualities should be united in a single ship, to be produced within the suggested limit as to cost. The aim should be to make each type as perfect as possible for one special service, whether as a ram, a floating gun-carriage, a torpedo-vessel, or a cruiser for the protection of commerce.

On a former occasion the designs were sent in to the Constructor's Department, where a natural preference was felt for the plans prepared under Government supervision. In the present case it would be more satisfactory if a Royal Commission were appointed composed of naval officers and men of science, without official bias, to whom the competitive designs should be referred, and by whom the premiums, which ought to be on a liberal scale, should be awarded.

The purview of Lord Dufferin's Committee was limited to the most recent designs of ships of war, all of which had emanated from Whitehall. The proposed Commission would have a wider field of observation, and their inquiry would be more exhaustive and more fruitful of suggestions for the future.

I have the honour to be, Sir,

Your most obedient servant,

THOMAS BRASSEY.

Observations of the 'Times,' November 15, 1875.

Times, Nov. 15, 1875. The feeling which prevails in the country at the present moment with reference to the Admiralty was happily expressed at the Guildhall dinner by Mr. Ward Hunt, when he stated the charge to be 'that the administration of the Navy is in a state of paralysis, and that it manifests the existence of great incompetence and weakness.

We had never seen it put so plainly, for a certain forbearance restrains the utterances of public criticism. But when it is placed before us in this light, and illustrated in the very act of exposition, we cannot but recognise in the First Lord one of the qualities of a statesman—the faculty of appreciating the sentiments of his time. There really does appear to be 'great incompetence and weakness' in dealing with the difficulties of naval administration. It would hardly be polite to attribute the anxiety entertained on this head to a distrust of the principal members of the Board, or to an idea that the permanent organisation of the Department is, in some important quarters, unsound or personally defective. Still, within the limits of propriety, we may express a doubt if the Admiralty, such as we find it, is strong enough for its place. In the matter of shipbuilding, they are altogether without any clearness of programme or comprehensivenesss of plan. In the matter of men, we are told that there were last year only two entries into the Navy, except from the class of boys whom we train to the service, and we read of wholesale desertion from the Pacific Squadron—enough to impair its efficiency. Even the excellence of our naval stores becomes the subject of misgiving when we find the safety of the 'Serapis,' on her present exceptional voyage, imperilled by the failure of two chain cables at a critical moment in a foreign port. *Times.*

We published last week a letter from Mr. Brassey on the subject of naval shipbuilding, which closed with an important suggestion. In the early part of this year he issued a pamphlet, in which he combated the policy of building very large ships, whether armoured, like the 'Inflexible,' or unarmoured, like the 'Raleigh' or the 'Shah.' He represented that 12 knots an hour is an unusual speed at sea, such as few cruisers or merchant ships of foreign nations are able long to maintain. If a war should break out between us and a maritime Power, our commerce would be exposed to the depredations of privateers, which would shortly swarm over the seas, and we should require every vessel we could buy or build to meet them. All we need aim at is that our cruisers should be a trifle faster than the cruisers or privateers of the enemy, and if 13 knots an hour would suffice for this, it is a waste of power to strive for 17 knots. The smaller speed, Mr. Brassey contends, can be secured from ships of 1,000 tons, like the 'Active,' while the 'Shah,' to attain the higher speed, has to be constructed of 5,400 tons. The price of unarmoured ships being about 50*l.* for every ton of displacement, it follows that for the cost of one 'Shah' we may build three of the 'Magicienne' or five of the 'Active' class with a speed of 13 knots, or six of the

Times.

'Daring,' or nine of the 'Arab,' or thirteen of the 'Coquette' class, with a speed of 9½ to 10 knots. Mr. Brassey argues that the torpedo is a great leveller, before whose stealthy advance alike the huge armoured monster and the unarmoured vessel, whether large or small, must equally fall victims. What folly then, he contends, for such creatures of a day or an hour to aspire to gigantic size! We should aim at dispersion rather than concentration. A contest between five of the smaller and one of the larger dimensions would be sure to end in victory for the greater number, when one well-planted blow from gun, torpedo, or ram is likely to be attended with fatal consequences to all the combatants alike. Meet the improvements in naval projectiles with tactics similar to those of the land forces when opposed to guns of precision. Advance in skirmishing order; put fewer men in each unit of floating power; provide torpedo-boats, sea-going torpedo-vessels, and rams, none of them exceeding 1,000 tons, and many of them much smaller; and then, says Mr. Brassey, we shall be far better prepared for the attack than if with two or three 'Inflexibles' we wandered about seeking for a foeman to meet us in line of battle. 'There is,' he tells us, 'perhaps only one essential point on which unanimity prevails. By universal consent an advantage in point of numbers is more important now than at any former epoch in naval history.'

Mr. Brassey's view is in many respects corroborated by the arguments of a 'Naval Officer,' whose letter we also published in the same impression. He criticises the account by Mr. Reed of the circular ironclads of Russia, and would be prepared to encounter in her own waters the completely armoured 'Novgorod' with six small unarmoured gunboats of even less dimensions than any of which Mr. Brassey has written. He starts with the assumption that the 'Novgorod' is only armoured with 9-inch armour, though we understood Mr. Reed to say that she carried armour of twice that thickness, or its equivalent. He then assumes that the armoured battery of the 'Novgorod' will present to the gunboats a target 30 feet in breadth and 7 feet in height, which they will all be able to hit, while they, presenting to her a smaller target, totally unprotected, will be in little danger of being hit by her fire. We quite believe that the chances of missing an object at 1,600 yards from a floating battery at sea are considerable, and that in the encounter supposed both monitor and gunboats would often fire without a hit. 'Gunnery,' as has been lately said, 'is not an exact science in a seaway.' But then it must be remembered that an ironclad will deflect many a shot which would destroy an unarmoured vessel, and that it is bad reason-

ing to presume every chance in favour of the fragile gunboat and against the strongly built ironclad. We should like very much to see the combat imagined by a 'Naval Officer,' and are ready to allow that, with skill and courage, favoured by good fortune, it might end in the manner he supposes. But there would be many chances, too, in favour of Goliath, and if the 'Novgorod' has no stronger battery than a 'Naval Officer' alleges, she has, at least, a stronger battery than any of our own 42 broadside ironclads, while the 'Admiral Popoff,' of larger tonnage, has a battery, we presume, which is stronger still. If a 'Naval Officer' is sound in his reasoning, it has been from the first a mistake to build ironclads at all, for no one doubts that ironclads are costly, and that if strength lies in numbers, the expenditure on ironclads of the last twenty years would have given us now at least six hundred instead of sixty ships of war. The current number of *Fraser's Magazine* contains a paper on the Navy, 'by an old Sailor,' which is worth referring to, and which concurs with both our correspondents in the value attributed to swift unarmoured cruisers. The author differs from Mr. Brassey in not being content to take the speed of our ships from their performances on the measured mile, and asserts that our fastest vessels are inferior in speed and steadiness to the steamships of several commercial lines across the Atlantic. He declares that when the 'Captain' foundered, the 'Inconstant,' the fastest of our men-of-war, with a strong southwest wind to favour her, and orders to use the utmost despatch, did not exceed 13 knots an hour in her voyage home with the news—a speed which the steamships of several Atlantic lines average throughout the year. If this be the case with one of our 17-knot frigates, what speed can we rely on from the 'Active,' of 1,000 tons? Amid these perplexities and discouragements as to the performances and capabilities of our ships of war, we think there is sound sense in Mr. Brassey's proposal that, instead of giving to the Constructive Department of the Admiralty a monopoly in the designs of our Navy, we should invite a competition between the private shipbuilders to produce for us, within limits of size and cost, designs for the various types of vessel which the country requires. Hitherto the Constructive has been the Consultative Department as well as the Executive Committee of the Admiralty, and on the only occasion when private enterprise competed for the honour of designing ships for the Navy the head of the Constructive Department was made referee and gave a preference over all the competing designs to the 'Vanguard' class of ship, which the Department had themselves devised. If the Navy was all that we could wish it, there might be no need to look outside

Times.

Times.

Whitehall. But the country has an abundance of skilful shipbuilders, and it seems a proper time to turn to them and see what assistance they can give.

Sir Spencer Robinson's Letter to 'Times,' November 22, 1875.

NAVAL CONSTRUCTION.

Sir Spencer Robinson.

Times, Nov. 22, 1875.

SIR,—It is not my intention to make any remarks on the criticism respecting the present naval administration which is to be found in the *Times* of the 15th inst., but only to observe on some suggestions made by Mr. Brassey and others, and partly adopted by yourself. I wish to be allowed to show—firstly, that the advantage of numbers, irrespective of quality, in our ships of war is hardly of the overruling importance which Mr. Brassey seems to attach to it, and, as a necessary consequence, that one of the wants of the Navy may still be that of large, powerful, sea-going ironclads; secondly, that providing the Navy with unarmoured ships of the 'Inconstant' class was not a mistake; and, lastly, to consider what are the reasons for believing that an invitation to private builders to produce designs for various types of ships of war would or would not be attended with any practical advantage.

First, as to numbers *versus* quality, let us consider what a squadron of ten swift ironclads, capable of steaming 14 knots (and I can easily lay my hands upon such ships) would do against twenty or more unarmoured ships such as Mr. Brassey suggests. He does not ask for a speed exceeding 13 knots, and by the size to which he limits them he has rejected an armour-piercing armament. Every ironclad in that squadron can act as a ram, and we must not suppose that it would not be accompanied by special rams and torpedo-vessels. On the contrary, we know well where to look for such deadly weapons. Could the ten ironclads be stopped from proceeding to their destination, whatever it might be, by the twenty or more unarmoured ships of Mr. Brassey's construction? I think the only answer to be given to such a question must be in the negative, and that every one in the least acquainted with naval affairs will admit that for the success of naval expeditions, superiority in quality—that is, in offensive and defensive power, comprehending, of course, armour, speed, armament, and handiness—must prevail over superiority in numbers; and, consequently, if the Admiralty can produce a ship—say the 'Inflexible'—possessing all these qualities in remarkable excess over those of any ship yet built, they have done well in constructing her. Ships with

Sir Spencer Robinson.

the qualities referred to are essential for the purpose of defeating expeditions against us, and equally so for the purpose of insuring the success of those which it may be incumbent on this country to undertake. And they will be so as long as other Naval Powers contemplate the use of ironclads for fighting battles on the sea.

Secondly, in addition to the necessities I have just glanced at, the British Navy has imposed upon it the task of protecting its commerce—first, on the high seas; secondly, in the narrow waters of our own coasts and harbours. The larger portion of that commerce must of necessity, in the first place, cross certain latitudes and longitudes on the ocean—that is, there are certain squares comprised between certain parallels of latitude and longitude through which all sailing ships must pass. Now, to keep our passage across these spots unmolested, it is evident that large, powerful, swift vessels of war capable of cruising are required; light, small, private vessels will not venture on such distant expeditions; an enemy wishing to interrupt our commerce must send ships of war to cruise for considerable periods of time in these regions, and we have ample knowledge of the class of ships more than one Naval Power intended to devote to this special service. For this purpose they built ships heavily armed, and with a proposed speed of 17 knots, though in practice this excessive speed was not realised. The intention to destroy our commerce by attacking it on the high seas, with vessels capable either of destroying all opposition or readily escaping from a superior force was evident, and the 'Inconstant' type was specially designed to defeat this intention. She was at the time of her construction the fastest sea-going man-of-war in the world, and she carried the heaviest armament ever placed in an unarmoured ship. It is well known that the swiftest ships of foreign navies are to be found among their iron-clads, and to guard against the possibility of one of these ships (though less adapted for cruising, and of inferior speed) destroying and capturing merchant ships in the presence of the 'Inconstant,' she was supplied with armour-piercing guns, her speed enabling her to close with anything she wished to destroy, her speed and armament combined enabling her to harass and keep at a distance the superior force of even an ironclad without very serious risk to herself. A class of ships realising these designs can never be considered a mistake, and certainly no such service as has been referred to could be performed by any practical multiplication of smaller, lighter, and slower ships.

But in addition to this type of ship, a host of smaller, yet exceedingly swift, vessels are needed to protect this commerce, when, having successfully crossed the ocean, it approaches our own shores

Sir Spencer Robinson.

in close proximity to the harbours of other Powers. It is here that it may easily be obstructed by swarms of light, swift vessels, unfitted for cruising, contemptible as far as armament is concerned, but all-powerful against unarmed merchant-ships. The rapid organisation and multiplication of vessels to meet this danger will severely tax the powers of any Naval Administration in the event of a maritime war, and the preparations to meet it are, it is believed, not yet begun. No number of light vessels of nine or ten knots speed would suffice. Swiftness as well as numbers would be essential. I have given a slight indication of the erroneous nature of the conclusions come to by Mr. Brassey. Notwithstanding some very valuable suggestions, their acceptance by any Administration could only lead to disaster and disgrace. Whatever may be said for or against particular ships, ironclad fleets must be met by ironclad fleets; whatever implement of destruction is brought against us, we must be prepared with one as good or better, if possible. Special ships will be required for special service. We have a double task imposed upon us in order to defend our commerce successfully; and perhaps I may be allowed to say, after some acquaintance with the powers of foreign navies, we possess, though in insufficient numbers, types, the excellence of which is universally acknowledged, comprising nearly all the classes of ship which we require. The naval constructors have done their part; it is for the Administration of the day to do theirs.

I cannot avoid most earnestly urging on their consideration the extreme undesirableness of tampering in any way with the high rate of speed that our naval constructors, under many difficulties, have succeeded in obtaining for our ships. Diminishing instead of increasing their speed is one of the most mistaken of Mr. Brassey's suggestions. It is likely to find favour with any Administration, for it involves a saving of original outlay. There are not wanting indications on the part of those in authority that this may prove an irresistible temptation. In a fleet action, the consequences attending a diminished rate of speed may not prove fatal, though they are not unimportant; but in duels between single ships, and with reference to the due protection of our commerce, the question of superior speed is, beyond all others, a vital one.

As I fear this letter is already too long, I must ask leave to reserve for another opportunity the consideration of the question whether these are or are not good reasons for inviting private shipbuilders to design ships of war for the Navy.

Your obedient servant,

ROB. SPENCER ROBINSON.

From 'Engineering,' November 26, 1875.

LARGE *v.* SMALL SHIPS OF WAR.

Mr. Brassey's recent letter to the *Times* does not fulfil the promise which he gave some time back of becoming a really valuable critic of naval affairs, and we should hardly think it required serious discussion were it not that it has been made the text of much writing since. It derives importance, too, from the general accord between the writer's views and those of the *Times*, which are calculated to work quite mischief enough without the support of a man so sensible, and usually so practical, as Mr. Brassey. *Engineering*, November 26, 1875.

Its argument, which is familiar enough, appears to us to be this: Actions are likely to be decided much less by artillery fire, and much more by rams and torpedoes, than heretofore. The chances of destruction, for each individual ship, are much increased, and neither size nor power will avail to reduce them. Therefore, let us not put all the eggs into one basket, but have as many ships as we can get for our money. Ten small ships, suitable for engaging the 'Inflexible,' and collectively much more formidable, can, according to Mr. Brassey, be built for the cost of that vessel. They are to be specially designed for use as rams; they are to have 'unquestionable mobility, including in the term not merely speed but facility in turning'—whence we presume, they are intended to be as fast as the 'Inflexible,' or to steam fourteen knots at least—and they are to be armoured on the bows. They are not, apparently, to carry guns, or at any rate armour-piercing guns. Their size is to be limited to 1,000 tons—whether measurement or displacement is meant is uncertain—and it is stated that they can be built for 50,000*l.* apiece, or for one-tenth of the cost of the 'Inflexible.'

As these vessels are to fight by ramming, and perhaps—though this is not stated—by discharging torpedoes, it is clear they must expose a great deal more than their bows to the enemy. Except during the few seconds of actual approach to ram, they would as often expose their sides as their bows, so that they would be practically unarmoured ships, while it would be impossible to give them such protection, even on the bows alone, as would be of the slightest avail against the 81-ton guns of the 'Inflexible;' indeed, any thickness of armour which could conceivably be carried upon *any* small ironclad, even though much larger than those Mr. Brassey proposes, would be useless for this purpose. The lives of his vessels would therefore be at the mercy of a single shot, just as though they

Engineering.

were totally unarmoured. This fact—which we assume needs no further argument for its establishment—is important, because the only points which seem to distinguish Mr. Brassey's proposal from others long since condemned are the use of the ram instead of artillery fire, and the pretence of employing an ironclad flotilla instead of unprotected ships. The latter claim its author will probably be glad to give up, when challenged to explain how he is going to combine the qualities and dimensions he speaks of, and his scheme will then be nothing more than that put forward by Colonel Strange some three years ago, with the difference that the flotilla of 'small, swift, handy, unarmoured ships' will fight with their stems instead of with guns, and must therefore be more heavily built. Naval officers of the kind whose opinion carries real weight in the profession are perhaps not so indifferent as Mr. Brassey about artillery fire, and might insist upon having it, and in that case the rams, as compared with the 'gun carriages,' would have to be still heavier, costlier, and less numerous.

It is nearly three years since Colonel Strange's proposal was discussed in these columns, and conclusively shown to be absurd, and his vessels impossible.[1] Since then we believe nothing has been heard of them, and we certainly did not expect to find them revived by a writer usually so sensible as Mr. Brassey. The simple fact is that a 1,000-ton vessel possessing the qualities he speaks of is an absurdity. Extreme 'facility in turning' implies shortness, and unfavourable lines for speed, and consequent large engine power and coal supply. Power to ram with safety to herself implies great structural strength and weight, and unless all the safeguards thought necessary in modern fighting ships are to be given up, there must also be such arrangements of double bottoms, minute subdivision, &c., as has never been attempted yet in a sea-going ship of 1,000 tons. In short, the vessel must be as unlike as possible in every respect to Mr. Brassey's steam yacht—which latter offers about the only possible model upon which a 1,000-ton man-of-war, able to steam 14 knots, could be designed. If Mr. Brassey will be content with 8 to 10 knots, low freeboard, and very small coal supply, it may be possible to provide him with 1,000-ton rams which might prove formidable auxiliaries for harbour defence, but which will be utterly unfit to keep the sea in search of a hostile fleet. If he wants something able to replace the 'Inflexible'—that is, to keep the sea for considerable periods—we do not hesitate to say that each of his sub-

[1] See *Engineering* for December 20, 1872. Paper entitled 'Armour or no Armour.'

stitutes will displace 3,000 tons at least, and cost at least 150,000*l*. In short, he will get three bad rams in exchange for the 'Inflexible,' and we wish him joy of the bargain. *Engineering.*

Lest this should be thought an over-statement it may be worth while to recall the particulars of existing ships which more or less correspond with those proposed by Mr. Brassey, either in size or qualities. In the first place, there is a class of modern sloops, of which the 'Amazon' (lost by collision with the 'Osprey') was one, rather exceeding 1,000 tons, and rising to about 1,200 in later examples. These are wood-built, of light scantling, of course not subdivided in any way, or carrying an ounce of armour, utterly unfit to ram anything (as the 'Amazon' showed), and of a shape which, though giving sufficient handiness for the duties which they fulfil, is not such as would suit Mr. Brassey. With all these advantages their speed is about twelve knots. If it were conceivable that they could be changed into iron-built rams of like measurement, the effect of the change upon their speed and engine power can be easily imagined. They carry four light guns, it is true, and more spars and top-hamper generally than Mr. Brassey, we presume, would desire for his rams, but all the weight he could save in these directions, or even by total dismasting, and a great deal more too, would be wanted in the coal bunkers, if there were the least talk of interfering with the present sail equipment. The class of sloops referred to, it should be added, are not failures by any means, but are considered successful examples of what may be done on the tonnage. None have been built very lately, but at present prices the cost would far exceed the 50,000*l*. set down as the limit by Mr. Brassey.

In the 'Magicienne' class we have unarmoured corvettes of about 1,400 tons (1,900 displacement) with thirteen-knot speed. This is obtained, as in the last class, only by a lightness of construction which would put ramming an ironclad out of the question. They carry fourteen guns, and considerable retrenchment of weights might be made by giving up these, and part or the whole of the sail power; but it would all be wanted, and more too, in the coal bunkers. The cost of this class, for hull and engines, is at least 70,000*l*.

Finally, we take the unarmoured corvette 'Rover,' somewhat, but only slightly, exceeding the speed required. She is iron-built, and is designed for ramming, though hardly fit, we should suppose, to measure her strength against the armour plates of the 'Inflexible.' Still, she is a ram, and the smallest high-speed ram in the Navy.

Engineering. Her armament is little heavier than the 'Magicienne's,' and, as in former cases, any retrenchment of weight would be swallowed up in the necessary addition to the coal supply, if the vessel were required to keep the sea in any other shape than that of a full-rigged ship. Well, the contract price for the hull and engines of the 'Rover' was 161,000*l.*, and her displacement is 3,500 tons. This great size and consequent cost have not been given to her wantonly. Except the 'Active' and 'Volage' (about 500 tons smaller, and not able to act as rams), she is the smallest fourteen to fifteen-knot ship in the Navy, and her armament is relatively light. She has been made so large simply to enable her (being sea-going and a ram) to be made so fast, and no ship so fast (and also sea-going and a ram) is likely to be made much smaller. We are aware that she differs in many ways from the ship Mr. Brassey requires, but the above brief description gives, nevertheless, some means of judging of the possibility of getting like speed, structural strength, seaworthiness, and power of keeping at sea (to say nothing of partial armouring) on a measurement of 1,000 tons. It is obviously impossible, and we believe that in admitting the possibility of such a vessel as Mr. Brassey suggests being constructed on a displacement of even 3,000 tons, and for 150,000*l.*, we have conceded more than is necessary. His whole scheme is a chimera. With *ten* such vessels as he asks for we should doubt his defeating the 'Inflexible.' With *three* we presume he himself would have no doubts: we have none.

Like many others, Mr. Brassey has forgotten that:

(*a*) A ram requires such structural strength as cannot be given to a small vessel without making her heavy and slow.

(*b*) Fourteen-knot speed is impossible in a sea-going (and sea-keeping) ship of 1,000 tons, if built or equipped (even without ordnance) in the manner necessary in a cruising man-of-war; much more so in a ship required to be built as a ram.

(*c*) A ship's fighting power, especially with regard to speed and capacity for carrying armour, increases in much more than the simple ratio of increased size. The fighting power of a 10,000-ton ship cannot be split up into ten parts and still remain as great.

In a pamphlet 'On Unarmoured Ships,' published by Mr. Brassey last summer, is a description (page 31) quoted from the American *Army and Navy Journal*, of an American torpedo ship called the 'Alarm,' the dimensions of which are 70 feet long, 28 feet wide, and 10 feet draught of water. She carries, or is to carry, a 15-inch smooth-bore 'on the bow,' and four Gatlings. 'The gun and bows are protected by 4 inches of plating, and it is intended to put

on 3 inches more.' The crew numbers 65, and the speed is not stated, but she carries five days' coal. On the following page Mr. Brassey expresses his opinion that a squadron of ten torpedo ships, costing 40,000*l.* each, and steaming 'not less than fifteen knots,' would be 'a much more important addition to the Navy than a colossal "Inflexible."' It looks very much as though the Yankee torpedo ship (whose displacement would apparently be something approaching to 1,000 tons) inspired Mr. Brassey's vision of a torpedo squadron, and that when the loss of the 'Vanguard' brought ramming into fashion he thought it better to turn his torpedoes into rams before writing to the *Times*. *Engineering.*

Having made clear how greatly Mr. Brassey has exaggerated the force which, in the form of small rams, could be brought against the 'Inflexible' at a cost not exceeding her own, it may be worth while to ask why, in all these discussions, the large ironclad is assumed to be so helpless. Surely she has the same facilities for torpedo work as the others. There are such things as defensive torpedoes; a well-contrived defensive system of Harvey torpedoes towed during action would make either ramming or offensive torpedo practice very hazardous work. If anybody believes very strongly in fish torpedoes used by ships while moving about in action, the 'Inflexible' can be fitted to discharge them quite as well, and in as large numbers as any vessel specially called a torpedo ship. The 'Inflexible' with a score of Harvey torpedoes round her might surely make a decent bag with her big guns while the ten, or rather three, gunless rams or torpedo ships were trying to find out how to hurt her. If ever Mr. Brassey's ideas are carried out in practice we have no doubt his ships would carry one large gun each, but this would only enable three 81-ton guns, either unprotected or very ill-protected, to be brought against four similar guns, covered by armour which, though not proof against a direct hit, would afford valuable shelter against three hits out of four. The ironclad, moreover, would use common shell with large bursting charges against her unprotected enemies, while they, nominally fighting with the same weapons, would have to content themselves with the far less destructive shell adapted for armour-piercing—an enormous disadvantage. The result of the action could not be doubtful, and it would be the same in whatever proportions or in whatever way the attempt was made to subdivide the money available for the attack. We, therefore, dissent not only from Mr. Brassey's conclusions but from the premises which we have attributed to him. We see no reason why artillery fire should be less effective than hitherto, or the action of rams

Engineering. and torpedoes so destructive as is commonly assumed, seeing that torpedoes offer almost as easy means of defence as of attack. The powerful ship has a good chance of stopping an approaching enemy with her guns, and her size—which implies greater structural strength and minuter subdivision—gives her a much better chance of surviving even a successful attack by ram or torpedo. From every point of view we believe the big ironclad to be the best fighting vessel.

Other suggestions in Mr. Brassey's letter do not seem to us happy. No doubt it would be well for ships to carry, if they can, fast steam launches for special torpedo services. But surely there is something fantastic in the idea of praising the 'Minotaur' for her great power of stowing such boats, as though that were more important than her own fighting qualities. When ships come to lowering their boats to fight their battles for them, they had better stay in port.

Mr. Brassey says that 'the attempt to build a vessel heavily armoured and armed, with a full spread of canvas, with great speed under steam, and fitted for use as a ram, must necessarily result in costly and unsatisfactory compromise.' Why 'necessarily,' if the utterly needless condition of a 'full spread of canvas' be given up as it ought to be in every real fighting ship, and as it has been virtually in the 'Inflexible?' Every other quality named is consistent with great size, and is relatively more cheaply attained, except ramming, as the size increases. Mr. Brassey says we breed widely different horses for hunting and for brewers' drays. True, but if it were a law of nature that a horse's speed increased (relatively to his cost) as he got larger, we should stick to the dray-horses for all purposes which required either strength or speed.

Letter from Sir E. J. Reed, K.C.B., published in the 'Times,' November 29, 1875.

Sir E. J. Reed, K.C.B. — *Times.* Nov. 29, 1875.

SIR,—It is all very well for the country now to cry out—perhaps a little too readily occasionally—about the state of the Navy, but so far as I can see, its condition is exactly what might have been expected as a consequence of the course which the present Government has taken, and to which the country has quietly submitted. When Parliament assembles next year, and has submitted to it the Navy Estimates, a period of three years will have elapsed since the naval

policy of the country was fairly and fully submitted to the House of Commons. Last year, with a new naval administration in Parliament of which no single member had ever before had the slightest experience of the naval service, it would have been idle to attempt to discuss naval affairs properly. The new Government introduced the Navy Estimates of their predecessors, and most of the debating that occurred consisted of altercations between the two front benches. I felt it my duty to give the Government what support I could, in the hope and belief that in the following year they would submit to us in the fullest manner their shipbuilding and other naval policies, and take the sense of Parliament upon them. But instead of this, not only was the Navy neglected this year by the Government, but it was treated in Parliament almost with contempt. Vainly did we from the opposite benches week after week endeavour to induce the Government to bring forth their proposals in detail. All our efforts were fruitless, and it was not until the end of the Session closely approached, and until our patience was utterly exhausted, that they consented to bring forward naval questions for discussion. When they did at length consent it was already too late. Every one who spoke had to speak under the greatest pressure, and I for my part was obliged to waive almost entirely the views I had desired to lay before the House. Meantime, while the naval service was being thus openly neglected, the First Lord of the Admiralty, under whose public protection that service now is, was engaging himself night after night in discussions upon an Agricultural Bill, much of his time and thoughts being devoted more particularly to the question of manure. I felt at the time amazed that a Minister intrusted with the care of so great and noble a service as the British Navy should have allowed that service to be treated in the manner it was, and still more that he should himself be the instrument of treating it with neglect and contempt. It used to be the wholesome practice of Parliament to take the Navy Estimates early in the Session, and troublesome and distressing to me, among others, as many of the debates were when I was at the Admiralty, we always felt that full debates in the House of Commons were, nevertheless, the greatest securities for all of us, and that our responsibilities, if increased in one way, were greatly lessened in the other by the publicity which attended our operations. Mr. Ward Hunt has seen fit, as our Minister of Marine, to withdraw the naval service to a very large extent from the view of Parliament during his term of office, deferring its interests day after day and week after week to discussions upon guano, and the consequence is that he now rests under a

Sir E. J. Reed, K.C.B.

Sir E. J. Reed, K.C.B. weight of personal responsibility from which I am afraid he cannot possibly escape. It may be very true that Mr. Disraeli is a powerful and an imperious Prime Minister, and no doubt in a primary sense the responsibility for preferring almost any subject to that of the Navy in the Parliamentary business of this year rests upon him; but there is nothing that binds a gentleman to take the post of the First Lord of the Admiralty, and nothing that compels him to hold it under conditions which are injurious to the public service; and for my part I cannot understand how even a dozen Prime Ministers could so far influence the mind of a man in that position as to cause him to become a willing instrument in the withdrawal of the Navy from Parliamentary view. I must say that I am not surprised that, with the Navy treated in this manner, and with Parliament, as a body, submitting to see it so treated, a widespread injury has resulted to the service. I do not wish to exaggerate minor incidents, and I think it most likely that there has been great exaggeration in the case of the 'Iron Duke' of Saturday last. I do not believe that any neglect, or anything short of a wilful interference with the working of several parts of her machinery, could possibly reduce the 'Iron Duke' to a sinking condition under the circumstances described. Still, it cannot be doubted that things have happened and are happening in the naval service of a very unusual character, and it is but fair and reasonable to connect them with the very unusual manner in which the Navy is being managed at the present time, and more particularly with regard to its withdrawal from Parliamentary control. I have thought it right to make these remarks because it is impossible for me, as a member of the House of Commons, to separate myself from all responsibility for the naval policy of the Government, and it is equally impossible to exercise the smallest influence upon that policy if its consideration is confined wholly to the officers of the Admiralty and is withheld from Parliament. The ships that are now being constructed, for example, are of a very extraordinary character, and they ought to have been described to the House in the fullest manner. There are points deserving anxious consideration in connection with vessels of the 'Inflexible' type, and more particularly, perhaps, with those smaller vessels of that class which have never been described to us at all, although the Government have taken the power to build them. Concerning the 'Inflexible' herself, we are in Parliament entirely without the means of forming an opinion even upon features which are of vital interest. If the country submits to this state of things, and openly abandons the naval service to the care of men who knew nothing about it

when they undertook to administer it, and who have since avoided the light and discussion of Parliament, they must be prepared to see the consequences both startling and alarming. Sir E. J. Reed, K.C.B.

With regard to the leading article in the *Times* of Monday, permit me to say that I repudiate altogether the inference that seems to have been hastily drawn from my Russian letters, to the effect that in setting forth the characteristics and qualities of the 'Popoffka,' I disclaim or denounce the vessels planned at the Admiralty by Sir Spencer Robinson and myself. All those ships we designed between the years 1863 and 1870, and the latest of them, therefore, five years ago, and I challenge any one to point to vessels in any other Navy that are equal to them date for date, or to deny that from the 'Bellerophon' on to the 'Sultan' they stood alone for strength and efficiency both when they were designed and when they were completed. In the annals of the British Navy those years 1863 to 1870, will, in my belief, stand marked as a period of great and striking progress, and will redound to the lasting credit of Sir Spencer Robinson, and of the Duke of Somerset, and other members of the Admiralties of those days. No doubt it would suit the style and sentiment of many men, if connected with such a period of naval construction, to rest content with its results; and probably many persons in my place would shrink from speaking henceforth with favour of anything new that could be brought into competition with them. But to my mind such a course would be contemptible to the last degree, and I shall not be deterred for a single moment from discussing frankly and freely the future developments of naval construction by the fear that something I may say may be tortured into a depreciation of the vessels which I designed for the Admiralty from five to twelve years ago. But so far am I, in my remarks upon the 'Popoffka,' from discrediting my former work and principles, that I maintain that all that I have lately written goes to further the very principles for which I laboured when in office. Long before I left office I wrote and published a paper, in which I said, as an epitome of my views, 'The merits of ironclad ships do not consist in carrying a large proportion of weights to engine-power, or having a high speed in proportion to that power; but rather in possessing great powers of offence and defence, being comparatively short, cheap, and handy, and steaming at a high speed, not in the most economical way possible, but by means of a moderate increase of power on account of the moderate proportions adopted in order to decrease the weight and cost, and to increase the handiness.' I often stated further that I had never been able to carry this

Sir E. J. Reed, K.C.B.

principle out as far as it ought to be carried; I have since designed for other persons shorter and broader ironclads than ever; and Admiral Popoff has, in frank and handsome terms, stated in your columns that he owes to my vessels, my words, and my writings the adumbrations of these circular vessels which he has so skilfully devised. Let who will, therefore, accuse me of inconsistency: I hold it to be not only consistent with, but a development of, my former labours to have said what I have in favour of Admiral Popoff's vessels.

There is one point, however, which was adverted to in a recent leading article of yours, and in which you might fairly be considered to have disclosed an inconsistency on my part if I left it without explanation. You justly said that I had hitherto exhibited a strong objection to very low freeeboard, and that I had not taken exception to the low freeboard of the 'Popoffka.' It is most true that I have always hitherto strenuously objected to such vessels as the American 'Monitors.' I do so now, and accidents such as have lately occurred in the Navy show, I contend, in an impressive manner, the justice of my view. If the 'Vanguard' had been a 'Monitor' of the American type, hundreds of men would have gone down in her. A very low freeboard in a long and narrow vessel means a small surplus of buoyancy, a short continuance of floating powers, a speedy end if overtaken by an accident. But in a circular vessel all this is very materially modified by the fact that the volume embraced by a cylinder is very much greater than the volume embraced by the sides of an ordinary ship of equal length of circumference and given depth—nearly three times as much; and besides this it must be remembered that the circular ironclads which I have described and discussed have both been built exclusively for shallow waters within the Straits of Kertch and at the mouth of the Dnieper. There is not, therefore, any inconsistency in my present and former views on this subject. If there were I should be very ready to acknowledge it, for I am under much graver obligations to be just and accurate now than to hold by every opinion I formed years ago.

The question at issue between Mr. Brassey and Sir Spencer Robinson is a very serious one, but in my opinion its solution is not far to seek. I should not be able to hold with Mr. Brassey in condemning such ships either as the 'Sultan' or as the 'Inconstant' in regard to the past; I should agree with all that Sir Spencer Robinson says on the subject. But Mr. Brassey is always wisely thinking of the future, and I go heartily with him—as I believe Sir Spencer Robinson will too—in saying that neither 'Sultans' nor

'Inconstants' should be repeated now that, by the manufacture of steel plates and by other improvements, speed and other results equal to theirs can be obtained with smaller vessels. It is by such agencies as these, and by other changes which I must not presume to discuss in your columns, that the progress of the Navy both in ironclads and in unarmoured ships has to be carried forward. To deliberately abandon either the highest speeds in some vessels or the most perfect offensive and defensive powers in others would be, if not to furl our flag, at least to tempt others to try and furl it. Sir E. J. Reed, K.C.B.

I have the honour to be, Sir,

Your obedient servant,

E. J. REED.

Further Observations of the 'Times.'

We publish in another column an interesting letter from Mr. E. J. Reed on the Navy, in which he charges the Government with having withdrawn the subject from Parliamentary discussion, and with 'widespread injury' having thereby 'resulted to the service.' He seizes the occasion to explain the consistency of his present advocacy of the 'Popoffka' with his former depreciation of 'Monitors,' and to intimate the drift of his opinion on the 'very serious question at issue between Mr. Brassey and Sir Spencer Robinson.' Mr. Reed is a man of too much originality and force of character to suffer his views of present expediency to be hampered by considerations of what he said or did under different circumstances ten years ago. He justly claims the right to 'discuss frankly and freely the future developments of naval construction, without being deterred by the fear that something he may say may be tortured into a depreciation of the vessels which he designed for the Admiralty from five to twelve years ago. It would be well if everybody possessed the same robust independence. No one is fit to be a public servant who cannot sever himself from his past work, leaving it to speak for itself, while he fearlessly pursues the realities of the present. Sir Spencer Robinson seems to live in the past, while the present and the future form Mr. Reed's domain. The one still hankers fondly after the last ironclad and fast frigate of his official rule; the other, holding that the 'Sultan' and the 'Inconstant' were ships to be proud of a few years since, goes heartily with Mr. Brassey in saying that neither 'Sultans' nor 'Inconstants' should be repeated now. On our comments on Mr. Reed's account of the 'Popoffka' at sea, we could not but remember the strange Times, November 29, 1875.

Times. resemblance between his report of her buoyant rising through and over the heavy swell and waves and what the late Admiral Sherard Osborn so often told us of the performances of the American Monitors. The evidence which satisfied the Admiral that we had much to learn as to the seaworthiness of low freeboard ships was ignored by the naval architect until he saw the fact himself. Yet it was a matter of the first moment for the guidance of our naval constructors. Admiral Osborn, as he informed the Committee of Naval Designs, consulted both Admiral Popoff and 'the man who took round Cape Horn one of those small turret ships built for a State on the other side.' The latter met a heavy sea and westerly gale the other side of the Straits of Magellan, steamed stem on to the sea for some time, but at last, with fear and trembling, determined to run for Valparaiso. 'The buoyancy of the vessel brought her up out of the sea in a way that quite astounded him.' The 'Monadnock' was a ship so low that Captain Colin Campbell, at Buenos Ayres, trembled to think of her going round Cape Horn. But she went, and in bad weather, too, and off the coast of California became unmanageable, her rudder-chains being badly fitted. She lay thus beam on to a very heavy sea, but was safe. Admiral Popoff told Admiral Osborn 'that the heaviest sea he had ever been in was when in a Monitor off the mouth of the Elbe, in a north-westerly gale, and that she steamed as fast as she could with safety, and the water and spray were flying all over her, so much so that the gratings on the hurricane deck were lifting with the water accumulated on her; but she was perfectly safe, and as steady as a church; he had no misgivings, as long as the hull was sound, and the hatchways perfectly secure, about the ship living in any sea.' All this evidence, and more, was before our naval architects when they persisted in their policy of building exclusively weak broadside ironclads. Yet they disregarded it. The monitors were then derided as 'half-tide rocks;' and we could not restrain the other day an expression of amused surprise to read the naïve delight with which Mr. Reed, a man of the future, now discerns for himself as novel the phenomena of the neglected past. However this may be, we are ready to acknowledge the consistency of Mr. Reed with himself, now and at all times, in desiring to make the British Navy worthy of our reputation and sufficient for our needs. It is not his fault if it is now deficient in some departments. There has been but little said of late to urge the Government to greater naval efforts, but his have been the most telling public utterances in that direction. The public ignorance about the Navy is immense. There is a feeling that if we spend ten millions a year on it, or more than twice the

aggregate expenditure of Germany and Russia, it ought to be sufficient. Mr. Reed, in a speech to his constituents about a year ago, pointed out that so much of the ten millions goes in pay and pensions and other matters, that for shipbuilding there remains only a small residuum, and that now shipbuilding is so expensive that 'for every hundred pounds which we had to invest in ships in the old days we have now to invest 170*l.* in order to carry the same number of men to sea.' Mr. Brassey says: 'Then build smaller vessels which will carry fewer men, and spread the same outlay over a larger surface, as the exigencies of naval warfare independently of cost require.' We were led the other day by Mr. Brassey into understating the amount of the present year's shipbuilding compared with the programme of Mr. Childers in 1869. But we still maintain, with Mr. Corry, that more ought to be spent in building unarmoured ships. Mr. Reed has schemes—which he hints at, without developing—of meeting the need of the times by the use in shipbuilding of steel plates and other improvements, calculated to give us equal speed and other results with smaller vessels. Admiral Sartorius and Mr. Nasmyth join in the cry that we ought not at the present time to leave the design of the Navy, both in kind and in detail, exclusively to the three or four naval architects who form or direct the constructive department at Whitehall. There is no other country which intrusts so much power and responsibility to so small a body of public servants. They advise the Admiralty what sort of ships to build; they frame the designs for their construction; and, more and more, they manage, through the Controller, the different dockyards which execute the designs. *Times.*

From the 'Times' of December 4, 1875.

SIR,—In reply to the letter you published from Sir Spencer Robinson on November 22, I ask permission to state the reason why, in my judgment, the public money was not laid out to advantage in building ships of the 'Inconstant' type. Whenever a foreign naval Power produces, or even seriously contemplates, the construction of ships with a speed of 17 knots for the purpose of harassing our commerce, it is the obvious duty of our own naval administration to provide a sufficient number of ships of superior or, at least, of equal speed. When, therefore, it was proposed to build for the United States Navy corvettes of the 'Wampanoag' class the Admiralty of that day wisely determined to supply for the British Navy a new class of *Sir T. Brassey.* *Times, Dec. 4, 1875.*

Sir T. Brassey. cruisers, which should be more than a match for their American rivals. As the latter were a complete failure, the large outlay on the 'Inconstant' proved in the event to have been unnecessary. This, however, is not an objection which can be fairly taken, for had the American ships been successful, we should have required for ourselves vessels as fast or faster than theirs. But while the naval policy which the 'Inconstant' represents will be generally approved, exception may be taken to the type proposed by the Constructors' Department for cruisers intended solely for the protection of commerce. Vessels capable of steaming 17 knots an hour, assuming that such a speed was required, might have been built for less than half the cost of the 'Inconstant.' With fine lines and good proportions it is not more difficult to obtain great speed in a ship of moderate dimensions than in one of enormous size. The 'Osborne,' a vessel of only 1,500 tons, or little more than a quarter of the tonnage of the 'Inconstant,' is now the fastest in the Navy.

Nor, again, was it necessary to build a ship of 6,000 tons in order to make rapid voyages across the ocean. As an ocean steamer the 'Inconstant' will not sustain a comparison with the ships of the Cunard service, of half the tonnage. The Cunard steamers, with the same favourable conditions as to smooth water and fine weather, under which the trials of Her Majesty's are conducted, traverse the ocean at a speed little inferior to the highest ever maintained by the 'Inconstant,' when steaming continuously at sea; and they possess one conspicuous advantage. They carry enough coal to make the passage from Liverpool to New York at their utmost rate of steaming, and they arrive at their port of destination with an ample reserve of fuel for contingencies. If they were not laden with cargo, their coal supply might be proportionately increased. In the case of the 'Inconstant,' on the other hand, the fuel is exhausted in 2¼ days' steaming at measured mile speed. It is impossible to accept such a ship as satisfactory for ocean service. True it is that at a reduced rate a longer distance can be traversed. But if the measured mile speed is never to be maintained when cruising, and is to be attempted only when in chase of an enemy actually in view, then we lose in a considerable degree those exceptional advantages for which so much has been sacrificed.

It is on the broad ocean, and not in the narrow waters inside the Isle of Wight, that the efficiency of a ship for the naval service can alone be effectually tested. It has been justly observed by Admiral Jurien de la Gravière that there is much to be learnt from long voyages at extreme speeds, sustained week after week with unbroken

regularity. 'When,' he says, 'I shall have seen a ship of war cross the Atlantic in company with one of our ocean-going mail steamers, I shall consider any further trial unnecessary.' The 'Inconstant' could not enter the lists with a Cunard steamer in such a contest, for when less than a third of the distance from Liverpool to New York had been performed, she would be obliged, owing to the exhaustion of her fuel, to give up the race. *Sir T. Brassey.*

It may, perhaps, be alleged that the powerful artillery supplied to the 'Inconstant' could not have been carried in a ship of less tonnage. But here a question might be raised as to whether such an armament is, in all respects, the most suitable. It has not been thought expedient to arm the 'Raleigh,' a later example of the same class, with armour-piercing guns; and if it were deemed desirable that such ships should carry heavy guns, it does not follow that all should be of the heaviest calibre. The French officers give a decided preference to the plan of a mixed armament; and for a mixed armament, including two or more powerful guns, more moderate dimensions would have been sufficient.

It is not necessary to carry further the discussion on the defects of the 'Inconstant.' Mr. Barnaby has shown, in the papers he has prepared for the Institution of Naval Architects, his clear appreciation of the expediency of observing reasonable limitations of size. The mistake to which your attention has been directed arose out of the attempt to combine too many nautical and fighting qualities in the same ship. The efforts of our constructors ought to have been directed to the single aim of producing a ship efficient for the primary object of giving protection to our shipping. In that case, they would have built a ship of smaller dimensions, capable of steaming upon occasion 17 knots, and with adequate stowage for fuel. Such a vessel would have been essentially a steamer. She would have been lightly sparred, and would have carried a mixed armament, chiefly of moderate calibre, yet including two or more armour-piercing guns. The extravagance of size and cost became unavoidable, when it was attempted to build a ship which should possess extraordinary speed under steam, sail as fast as the smartest frigates of former days, and which should not only be a more than equal match for cruisers of the 'Alabama' class, but be enabled, by means of a formidable artillery, to cope even with an ironclad, without very serious risks to herself.

To use a homely phrase, it is not wise to 'put all our eggs into one basket.' This is a sound maxim, even in the case of an ironclad of the 'Inflexible' type, which by means of armour, is secure, so we hope, in vital places, from the perils of shells bursting inboard. The

Sir T. Brassey.

maxim is still more applicable when we come to deal with a class of vessels exposed to destruction, not only from the ram and the torpedo, but also from projectiles of every description.

There is an additional source of danger in the later unarmoured ships, to which our older vessels were not exposed. In the wooden screw frigates and line-of-battle ships of earlier construction, the steam was used at a comparatively low pressure, and the boilers were so placed as to be beyond the reach of the direct hitting shot. In the more recent ships the steam is used at a higher pressure. The boilers are more exposed; the risk of injury from explosion in the engine-room is more serious.

All these are reasons for insisting on limiting the tonnage of unarmoured ships of war. Our aim should be to build for a given sum of money as many ships as we can, efficient for their several purposes. For constant cruising in remoter seas we shall require a greater area of sail, and we must be content with lower speed under steam. For service in the Channel, in the Mediterranean, and on the western coasts of Europe, where it is still probable that the decisive battles of the future, like those of the past, may be fought, the naval constructors may dispense with sail, and concentrate their ingenuity on the development of the most formidable powers of attack, in some ships with the ram, in others with the heaviest guns.

Naval officers and constructors are apt to assume that the sum of money at their disposal is an unlimited quantity. This, however, is not the case. In all countries wisely governed, and most certainly in countries governed by popular assemblies responsible to electors who, except under the temporary pressure of foreign complications, are more or less affected by an ignorant impatience of taxation, naval administrators must proceed on the assumption that there is an ultimate limit to expenditure. In our own country the public are doubtless less anxious for economy than for efficiency in naval administration; but the very abundance of his resources should impress a British Minister with a deeper sense of the national importance of the Navy, and his personal responsibility for the effective employment of the ample means at his disposal.

The sum of 100,000*l.* was named somewhat at a venture in a former letter as the limit of cost for designs to be submitted by the private constructors to a Royal Commission. I have since been informed that a ship of war is being built at the Thames Ironworks for the Portuguese Government, at a cost of 110,000*l.* She is 200 feet long by 40 feet beam. The engines are 450-horse power, and it is believed that a speed of 13 knots will be attained. The armour

has a thickness of nine inches at the water-line, and ten inches on the fore part of the battery. The bow is fitted as a powerful ram. Two 18-ton guns are mounted under a deck, covered with $2\frac{1}{2}$-inch armour, in a fixed battery forward. While it is intended that the ship shall be taken into action with an enemy in the end-on position, a stern gun of $6\frac{1}{2}$ tons is fitted under the poop, though not protected by armour. In these days of rams and torpedoes many officers would, I think, prefer to have five such ships under their command rather than one 'Inflexible,' and the cost of building would be precisely the same. *Sir T. Brassey.*

It is with regret that I find myself engaged in criticising in any particular the shipbuilding policy of an ex-Controller, to whom we are indebted for a fleet of ships of matchless individual power. For many years Sir Spencer Robinson worked indefatigably and most ably at the Admiralty, and it is a hard measure of justice that he should have been called on to retire from the service, as if he had been an idle man, and had not rendered the signal services, which all acknowledge, to his profession and to his country.

Mr. Reed having interposed—and he is most justly entitled to a hearing in any discussion on shipbuilding—I am happy to find that we are in accord on all the main points at issue. Mr. Reed is justified in claiming great credit for his designs for the 'Sultan,' and still more for those for the 'Hercules,' and it is satisfactory to know that his own high estimation of these ships—which might perhaps have been influenced by partiality—has been confirmed in the fullest sense by Admiral Porter in his reports to the Secretary of the United States Navy, and by the numerous imitations of the English types which have been constructed for the German Navy. Nor will any be found to differ from Mr. Reed when he condemns a cheese-paring policy in naval construction. The essential point is that the large amount we spend on our Navy should be judiciously applied. For my own part, I am convinced that it is a grievous error in our shipbuilding policy to allow 500,000*l.*—and we are threatened with a still larger demand—to be expended on a single ship, which, after all, is only imperfectly protected from projectiles, which is as liable as the weakest vessel of the fleet to destruction by rams or torpedoes, and which can claim no exemption, as recent experience proves, from all the various accidents of the seas, whether from wreck, collision, or defective machinery.

Mr. Reed says that we must have high speeds and the most powerful artillery in order to sustain the reputation of the British flag. But it is not necessary that all the elements which go to make

Sir T. Brassey. a powerful navy should be combined in a single ship. Once admit the necessity of reducing the cost of individual ships, and the varied qualities, on which Mr. Reed most properly insists, must be obtained by a judicious subdivision and classification of the fleet. Each type will be excellent in its own class, and specially adapted to a particular service. Here, again, I am a follower of Mr. Reed, for he, too, says that the aim should be to attain 'the highest speeds in some vessels, and the most perfect offensive and defensive powers in others.'

This extreme costliness has always constituted an objection to the larger ironclads, and the objection has acquired a greater force now that naval officers, and specially those at the head of foreign navies, have adopted the ram and the torpedo as their principal weapons. Our judgment in these matters must be swayed by the progress of events, and when the result of the collision between the 'Vanguard' and the 'Iron Duke' is compared with the former untoward experiment of the 'Amazon' and the 'Osprey,' it is natural that a higher estimate should be formed of the power of the ram. Steering and steaming qualities will henceforward be esteemed of more importance—at least, in vessels designed to act as rams—than the thickness of the armour or the calibre of guns.

As I shall not venture to address you again on the subject of naval construction, I ask leave to append a few observations on the recent disasters in the Navy. While their frequent recurrence must be a subject of the deepest regret, it is scarcely fair to make them the occasion for a party attack on the present First Lord of the Admiralty, who, as everybody knows, is not personally responsible for the navigation of Her Majesty's ships. These accidents must be attributed, not to the political Chief of the Navy, but to a defective system of training. In the theory of their profession, and in all that can be learnt in college or in harbour, our officers are probably more highly instructed at the present day than in any former period of our naval history; but drill and theory will not make an officer perfect in a profession which can only be mastered by practice at sea.

When Lord Nelson landed at Gibraltar in June 1805, he made the following record in his diary:—'I went on shore to-day, for the first time since June 16, 1803, and from having my foot out of the "Victory" two years wanting ten days.' It was by their constant practice at sea, stimulated no doubt by the perpetual anticipation of battle, that the illustrious officers of the great era in our Navy became such incomparable seamen.

Ironclads are bad schools for young officers. They cannot be handled without steam; and to keep them constantly at sea under steam would involve a large consumption of coal. Hence it follows that these ships are mostly in harbour. The lieutenants of the First Reserve ships have rarely an opportunity of taking charge of a watch at sea between sunset and sunrise. Even in the Channel Squadron long detentions for heavy repairs leave too little time available for instructing young officers in their duties at sea. The difficulty is even more serious in the case of the numerous lieutenants and sub-lieutenants, detained in harbour ships for months waiting their turn for appointments to a sea-going ship. We have some fine wooden ships in commission in the home ports. The 'Duncan,' the 'Revenge,' and the 'Aurora' can cruise under sail, and, if they were more frequently at sea, would be well adapted for training young officers. They are now almost always at anchor, and their officers can add little to their experience as seamen. The Admiralty are doubtless anxious to avoid unnecessary expense, but ropes and canvas should not be stinted in the instruction of officers whom we are bringing forward for the command of ships which cost 600,000*l*. *Sir T. Brassey.*

Having ventured on an opinion as to the weak point in our system of training, I suggest as a remedy that we should introduce on the home station the plan which has been adopted with so much advantage in the Mediterranean. A sailing tender of the 'Cruiser' class should be attached to each of the receiving ships, and a brig to each ironclad in the Reserve Squadron. If these vessels were sent constantly to cruise along our coasts, the officers would acquire the experience which is so essentially necessary both in watch-keeping and in pilotage. The vessels proposed would be obtained more cheaply from the private than the public yards. A sailing brig or barque of the highest class could be built for 20*l*. a ton. Vessels of a comparatively trifling value are better adapted than our costly iron-clads for the first essays of a sub-lieutenant.

I have the honour to be, Sir,

Your most obedient servant,

THOMAS BRASSEY.

Further Observations of the 'Times' on the Letters of Sir Spencer Robinson and the Compiler.

We publish to-day two more letters on the subject of the Navy. In a letter which we published on Thursday, Admiral Sir Spencer *Times, December 5, 1875.*

Times. Robinson showed cause why private shipbuilders should not, in any case, be invited to design ships of war for the Admiralty. Mr. Brassey, in reply to Sir Spencer's former communication, develops at length and with great clearness his objections to the colossal ship of any type; while 'Nemo,' who has ideas on the reform of the dockyards, discusses the questions now at issue before Mr. Stephen Cave's Committee as to our naval storekeeping. Sir Spencer Robinson has often displayed an intolerance of public criticism on the department over which, as Controller, he long presided. He used to resemble King Charles II., who told Lord Essex, when the nation murmured at the Dutch fleet under De Ruyter burning our ships in the Medway, that 'he did not wish to sit like a Turkish Sultan and sentence men to the bowstring, but he could not bear that a set of fellows should inquire into his conduct.' When a very competent committee of naval officers and men of science was appointed to examine and report on the designs of our recent ships of war, and ventured, while applauding the constructive department of the Admiralty, to express some independent opinions on the subject, Sir Spencer Robinson resented it as a personal attack, and published a counter-report to 'disculpate,' as he called it, the department which no one had attacked. His letter in Thursday's impression is free from any such reproach. He goes so far, even, as to admit the fallibility of Admiralty Constructors or Controllers of the Navy as well as Boards of Admiralty. 'All,' he says, 'have made mistakes.' But, he argues, the building of ships of war, like the building of Cunarders, is a *spécialité*, and it is reasonable to suppose that the men of special experience will excel in their special vocations. He does not doubt the ability or the science of private designers of ships, but the Admiralty designers have an advantage in the wider experience they can bring to bear on the special wants of ships of war, and in the mass of records, to which they have access, of all that has been done, ill or well, in the service. There is, of course, a large amount of truth in the argument derived from the accumulated stores of special knowledge in the possession of the Government servants. But it may be carried much too far. Indeed, it may be turned, as Mr. Brassey turns it, against the advocates for Government shipbuilding. 'As an ocean steamer,' he says truly, 'the "Inconstant" will not sustain a comparison with the ships of the Cunard service, of half the tonnage.' The building of ships of war is by no means confined to the Government dockyards in Great Britain. You cannot steam up the Thames, the Tyne, the Mersey, or the Clyde without seeing ships of war under construction for

foreign Governments. At the Thames Ironworks, an ironclad, which Mr. Brassey describes, has been just built for the Portuguese Navy at one-fifth of the cost of the 'Inflexible.' So, too, the cleverest contrivance for floating heavy guns which we have adopted in our Navy was the invention of Mr. Rendel, a private designer. All that can be really said for the 'accumulated experience' theory is that it ought to give our naval constructors great advantages, especially in the detailed contrivances and fittings of ships; but we always heard that it was precisely in these details that the ill-fated 'Captain,' the work of Captain Coles and Messrs. Laird, was thought by the men who tried her to excel. When the state of the Navy was under discussion four years ago, the late Mr. Corry, who knew the Admiralty well, stated in the House of Commons that 'he had a great respect for the gentlemen who formed the council of construction, yet they hardly held such a position that the country would leave to them the whole question of our coast defence.' *Times.*

Sir Spencer Robinson himself makes one suggestion, which is in the same direction as that which we lately proffered. He strongly advocates the reference of every new design for a ship of war to an examining council. No man can design a ship who is not a naval architect; but many a naval officer or private shipbuilder, who could not himself design a ship, is highly competent to criticise and express an opinion on the designs of a naval architect. When the ship is built, criticism becomes ungracious, and is at any rate too late for improving the particular construction. If the Admiralty had its Privy Council, from which committees might be summoned from time to time for advice, it is probable that great advantage might ensue. The same men would not always be summoned, because the same qualities would not be always required in the adviser. If a ship were required for ocean cruising, the builder of vessels for the packet service of great companies might be a most important councillor, while another man might have a fuller knowledge of the requirements of a fighting ship. The only committee which now reviews the suggestions of the constructive department is the Board of Admiralty itself, and the members of the board are selected on other grounds than their knowledge of naval architecture. There never was a First Lord of the Admiralty who had more experience and self-reliance than Mr. Corry, but he one day expressed himself to the effect that any First Lord or board which overruled the Controller of the Navy on the subject of shipbuilding would incur a very serious responsibility. We go further than Sir Spencer Robinson in wishing to separate the Controller of the Navy from the

Times. naval architects, the designing of ships from the management of dockyards, and to make each dockyard complete and efficient in itself, with its own manager on the spot, and a general superintendence only in the Controller at Whitehall.

From 'Engineering,' December 10, 1875.

MR. BRASSEY AND THE NAVY.

Engineering, Dec. 10, 1875. Since the publication of our comments a fortnight since upon Mr. Brassey's proposals, a second letter has appeared in the *Times* from that gentleman, in which he takes somewhat different ground. In his first letter we certainly understood him to recommend that for the heaviest fighting the 'Inflexible' type should be superseded by small partially armoured rams of about 1,000 tons, and costing 50,000*l.*, and this size and cost were further indicated by the argument that *ten* such ships must prove more than a match for one 'Inflexible.' Of their intended speed no direct statement was made, but it might be inferred from an expression used about them, and from the fact that they were to contend with a 14-knot ship, that a considerable speed was contemplated. Having in view a reference to the same subject in a recent pamphlet by Mr. Brassey, we therefore thought ourselves justified in assuming that his small rams were meant to be of 15-knot speed, and we discussed them upon that assumption. It was easy to show, of course, that such vessels were impossible; and the conclusion was that, if the policy of preferring numbers to power (coupled with the use of high speed) were to be adopted, its advocates, working only with a fund equal to the cost of the 'Inflexible,' could not hope to bring against her more than about *three* vessels of the type proposed. In other words, a 15-knot ship, if built strong enough for ramming, and equipped with all the stores and appliances necessary for a sea-going and sea-keeping man-of-war, is not likely to displace less than 3,000 tons, nor cost less than 150,000*l.* as a minimum—and this without carrying an ounce of armour or any really heavy ordnance. Had we taken 14 knots instead of 15 as the measured-mile speed of the so-called 'small' rams, we might perhaps have admitted the possibility of constructing *four* for the cost of one 'Inflexible;' but our belief in the superiority of the latter to any force which might in this way be brought against her would not have been in any degree modified.

In his latest letter to the *Times* Mr. Brassey drops his little

1,000-ton prodigies and takes up with a more reasonable, because possible, type of vessel, viz., a small ironclad actually building in this country for the Portuguese Government at a cost which would admit of *five* (instead of ten) being constructed for the price of the 'Inflexible.' Of this ship we know only that she is 200 feet long by 40 feet beam; that her tonnage (not displacement) is 1,497; and that her engines are of 450-horse power nominal. She is to carry two 18-ton guns, has a 9-inch belt, and some 10-inch armour over the guns. Her description suggests the attainment of extremely good results for the size and cost (110,000*l.*, according to Mr. Brassey), but her armour would be little more than a useless encumbrance against 81-ton guns, while her own guns might as well be left at home for any impression they could produce on the 22-inch plating of the 'Inflexible.' The proportion of engine power to tonnage is so considerable that a fairly high speed may be looked for, though not the 13 knots expected by Mr. Brassey; but we cannot believe, without knowing a great deal more of her than has yet been stated, that this little vessel will be considered by British officers a satisfactory ship for fleet cruising in war time, even apart from the question of fighting capacity. Either she will be much too slow to manœuvre against ships of the 'Inflexible' class, or she will be deficient in sea-keeping qualities of equal importance. In either case no multiplication in number will enable her type to contend permanently against that of the 'Inflexible,' while even if speed and sea-going qualities were perfect we should still say that five such vessels would be no match for her. Their armour would leave them at the mercy of every shot from the 'Inflexible,' who would be proof against their guns, and they would have, in fact, no hope whatever except in the little-understood arts of ramming and torpedo work, the practical value of which is still untried. An arrangement by which a ship might be surrounded with defensive torpedoes, as we suggested lately, might render ramming and torpedo attacks too dangerous to be attempted without great circumspection and choice of opportunity, and in that case the battle would be practically fought out by the guns—when big guns and thick armour would have all the advantages they have hitherto been credited with.

Engineering.

Mr. Brassey writes so ably, and for personal reasons commands so much confidence, that it will not do to leave his fallacies to work their own condemnation. He is, we presume, a probable future Lord of the Admiralty, and he has this further advantage that whoever assumes the offensive against the Admiralty of the day is sure of popular support. We, therefore, desire to call attention to the recent

Engineering. apparent change in his plans as proof of their vagueness and undigested character. He begins by the startling statement that for the cost of the 'Inflexible' *ten* rams may be built, not wholly unprotected by armour, and (by implication) fast enough and seaworthy enough for the same class of warfare the 'Inflexible' is designed for. Given these ten small ships, the argument for their superiority to the one large one is plausible, and of a kind which takes readily with the public—probably much more so than the argument, simple as it is, which proves the ten ships to be myths. But when, a few days later, Mr. Brassey drops all reference to the ten ships, and in place of them recommends five of twice the size, and of avowedly inferior speed, the public will begin to doubt the counsels of a writer who deals thus loosely with matters of the highest importance, and to question whether the one scheme has any better foundation than the other. We say it has not distinctly.

We think the explanation of Mr. Brassey's recent letters is that he has taken hold of some sound ideas with regard to unarmoured ships, but has unconsciously misapplied them to ironclads. He sees that small and comparatively slow cruising vessels have great value for the protection—and destruction—of commerce, and he has argued wisely against the idea, prevalent some time back, that nothing could be of any use which did not steam at an almost fabulous speed. He has also seen the value of the 13-knot class of sloops or corvettes, the convoying and privateer-catching class, and has understood that these should form the bulk of our unarmoured fleet. So far we go with him entirely, for these views were strongly urged in *Engineering* a year before Mr. Brassey's sensible pamphlet on the subject appeared. But though it may be good policy to build two 13-knot 'Magiciennes' of 1,900 tons displacement each rather than one 15-knot 'Bacchante' of 3,900 tons, it may be quite wrong to do the same thing in the case of ironclads. Unarmoured ships are not designed so much for fighting as for worrying other ships smaller than themselves: no one advocates resolving the 'Bacchante' into two 'Magiciennes' in order that they may get the better of her in fight. That course is taken to gain quite another end, viz., as much dispersion as possible, which is a desirable quality in dealing with merchant ships and privateers, but not in dealing with enemies like the 'Inflexible.' When an 'Inflexible' has been resolved into ten parts, or five, Mr. Brassey does not (we presume) propose to disperse them; he will keep them together to act in a flotilla against the ship which could certainly destroy each of them singly. The argument in favour of dispersion for its own sake, which applies rightly to unarmoured

ships, does not apply to ironclads at all, for it is agreed that they are maintained almost solely for the purpose of fighting each other in fleets, whether of big ships or little, as much concentrated as possible. The little ironclads—or substitutes for ironclads—can have nothing to recommend them except the claim that, collectively, they are stronger in fight than the same money's worth of big ironclad, and this claim we have given reasons for rejecting. *Engineering.*

As we have thus found fault freely with the speculations of others who think that the torpedo and the ram have entirely revolutionised naval warfare, it is but right that we should state our own views of these important inventions. For the present, then, we regard them as untried appliances which it would be equally dangerous to neglect, or to treat as anything but adjuncts to better known methods. Of ramming we know practically nothing from experience. It needed no experience to tell us that if a sharp-nosed, strongly built vessel strikes another at speed below the armour-plating, she will make a considerable hole in her. If you hit your opponent in the eye he is sure to be incommoded, but the 'noble science' consists in knowing how to do it. It is the same with ramming. We know the result, without any illustrations, but we do not know how to do it, mainly because there have been few opportunities of trying. The Americans did it on both sides, but generally against opponents lying nearly motionless on the water. The Austrians, admirably handled by an officer whose deserts were never sufficiently known to his countrymen, sank one ship (a wooden ironclad) and injured, or rather frightened, others at Lissa, but the bad management of the Italians in that battle deprives it of most of its value as a lesson. Since then there has been no chance of learning the value of the ram against a properly handled enemy.

ON GUNBOATS.

SIR,—It may not be uninteresting to many of your readers to know that the two gun-vessels recently constructed by Sir William Armstrong's firm for the Chinese Government were at Aden on the 16th of April, having performed their long voyage from England satisfactorily. The opening of the Suez Canal, which has made it practicable to dispatch vessels of small size and limited coal-carrying capacity to those distant Eastern waters, in which our commerce is so important, has added a new element to the many complications of the naval problem. It is certain that small vessels can now be employed with far greater advantage than formerly. The most im- *Sir T. Brassey.* *Times, May 30, 1877.*

Sir T. Brassey.

portant positions which our naval forces would be required to occupy, such as the Straits of Gibraltar, Bab-el-Mandeb, and Singapore, are eminently adapted for the effective use of small vessels armed with powerful weapons.

It has been urged most strongly by Mr. Barnaby that every monster ironclad should be supported by a flotilla of gunboats. Has due weight been given to this suggestion of the Chief Constructor, which received the strongest support from Sir Spencer Robinson and other authorities?

As skirmishers, in combination with the monster ironclads of the 'Inflexible' type, gunboats of the type designed by Mr. Rendel would be invaluable. In addition to the attendant flotilla of gunboats, each armoured ship should carry torpedo-boats of great speed. Mr. Samuda, some years ago, urged the Admiralty to introduce into the Navy swift torpedo-boats built on Mr. Thorneycroft's principle. His suggestion should have been more promptly followed. At the commencement of an action the torpedo-boats should be lowered, ready, as soon as the contending fleets had opened fire, to rush in, under cover of the smoke, and destroy the enemy's ships. When it is remembered that the blow from a single torpedo would prove fatal, and how improbable it is that such tiny craft, steaming at the rate of 17 knots, and enveloped in smoke, will be struck by heavy projectiles, it can scarcely be doubted that victory would incline in favour of that fleet which should possess the greatest number and the most effective of these light-armed naval skirmishers.

Again, considering how impossible it is to construct an invulnerable ship, and that the costliest ships are almost as liable to destruction as those of a smaller and less costly type, ought it not to be a cardinal maxim with naval constructors and administrators to distribute the strength of the Navy into as large a number of ships as may be, taking care, of course, that no ship shall be built which is too small to be thoroughly effective in its own particular class? Let us seek for the best practical application of this principle. If, on the one hand, we agree that the 'Inflexible' type is too large, and, on the other hand, insist that no design shall be accepted which is not adequate for the special object in view, the only solution of the problem is to be found in the abandonment of the attempt to unite in one hull all the qualities to be desired in a ship of war. The exaggerated dimensions of our latest ironclads are due to the attempt to carry the heaviest guns that can be constructed, under the protection of impenetrable armour, and at extreme speeds. The result has been a growth of dimensions and a corresponding diminution in the number

of ships which can be built for any given sum of money. When we consider the formidable powers of the torpedo and modern artillery, and the liability of the most powerful ship to instant destruction, the tendency to concentrate our fighting strength in a few gigantic but highly vulnerable ships is much to be deprecated. And not only is there a reduction in the ships; there is also a reduction in the number of guns, which, viewed in connection with the inevitable uncertainty of aim in the excitement of battle, is equally to be regretted. *Sir T. Brassey.*

The expediency of adding largely to the dimensions of an armoured steam ram, for the purposes of mounting an armament of two or four 80-ton guns, is open to question on another ground. A captain may hesitate to open fire, and to obstruct his field of view by the smoke of a heavy cannonade, when he sees a cloud of torpedo-boats hovering round him, only deferring their fatal assault until their movements are rendered invisible to the enemy by the smoke from his own guns.

How, then, are we to meet these various and complicated conditions with which the naval constructor has to deal? It can only be done by adopting distinct types of ships for the use of the gun, the ram, and the torpedo respectively.

The artillery of the fleet should be mounted on floating gun-carriages of the 'Gamma' type, designed by Mr. Rendel. For the torpedo each large ship should carry two or more of Mr. Thorneycroft's swift launches. For the purposes of ramming, a swift armoured ship of handy proportions is required; and, with the view to a limitation of size, and in order to secure that quality of handiness so vitally necessary to an effective ram, these vessels should not be encumbered with armour-protected guns.

Let progressive, unprejudiced naval officers compare the kind of force that could be created for a given sum of money, if constituted according to the suggestions here offered, with a fleet composed of vessels of the 'Inflexible' type. I assume that armoured vessels can be built for 50*l*. a ton. The 'Inflexible' type, in round figures, has a tonnage of 10,000 tons, and costs 500,000*l*. Five millions sterling, therefore, would produce only ten 'Inflexibles,' which, powerful as they are, possess no special defence against the torpedo, are armoured with penetrable armour, and together carry only 40 guns. A fleet of 'Inflexibles,' it will be remarked, costs 125,000*l*. a gun.

I venture to believe that a like sum of 5,000,000*l*. might be much more effectively applied in the construction of the following vessels :—

Sir T. Brassey.

1. Thirty armoured steam rams of 2,000 tons, without guns, costing, at 50*l.* a ton, each 100,000*l.* . . .	£3,000,000
2. Sixty gun-vessels of the 'Gamma' type, armed with one 38-ton gun, two 12-pounder breech-loading guns, and one Gatling gun, each 25,000*l.*	1,500,000
3. Launches on Mr. Thorneycroft's plan, and other descriptions of offensive torpedoes and torpedo-boats .	500,000
Total . . .	£5,000,000

For operations in European waters, in the Mediterranean, the Red Sea, the Straits of Singapore, in short, along the whole line of our communications with the East, such a fleet as I have indicated would, in the hands of dashing commanders, be more effective than ten 'Inflexibles.' Is the ram, as some think, the most formidable weapon of the Navy, and is the quality of handiness the first condition of efficiency? Then thirty rams are matched against ten, and the smaller vessels, being the more handy, are the more effective. True it is that the 'Inflexibles' could steam faster than the smaller rams, and could therefore place themselves beyond their reach; but such powerful vessels were surely not built to run away from an enemy.

Is the gun the weapon on which we chiefly rely? In the plan suggested, eighty guns are carried as against forty; and they are, for many purposes, mounted so as to be more available than if carried in ships of the 'Inflexible' type. For bombardments and for coast defence, a shallow draught is often essential in the vessels employed. It may be necessary that they should pass over shoals or navigate shallow channels. St. Petersburg and Cronstadt were inaccessible to our line-of-battle ships. They might have been destroyed by gunboats. Take, again, the question of coast-defence. What could be done to protect the Thames, the Mersey, or the Humber, by ships drawing thirty feet, in comparison with the services which could be rendered by gunboats capable of navigating the in-shore channels, and threading their way through the intricate maze of mud flats and sand banks, with which the estuaries of our largest rivers are beset?

In a naval engagement the utility of gunboats would be scarcely less apparent. Having double the number of guns, the chance of delivering a fatal shot is largely in favour of the fleet supported by a flotilla of gunboats. It may be thought that the gunboats could not sail in company with the larger ships. The plan of towing would meet this difficulty.

For an example of what may be done with torpedo-boats the recent experiments at Cherbourg are conclusive.

A general review of the situation cannot fail, as I think, to convince dispassionate minds that our present large expenditure on ironclads would be more judiciously applied in perfecting our means of attack rather than in a hopeless competition of armour against guns. *Sir T. Brassey.*

In France, where the art of naval design has reached its greatest perfection, and where original ideas in naval architecture are boldly and freely adopted, some of the most eminent constructors have already pronounced the days of ironclads to be numbered. In the United States no attempt has been made to construct sea-going ironclads. Those produced in Russia have proved failures. The other Powers are followers of our example in matters naval.

If the money expended so lavishly in vain devices for the protection of our ships were applied to the development of their offensive power, we should see the battle-ships of rival navies relieved of the burden of armour. It would be acknowledged that armour was useless as a defence against a cloud of gunboats, torpedo-boats, and rams, which we could send forth to deliver an irresistible assault.

I have the honour to be, Sir,

Your obedient servant,

THOMAS BRASSEY.

Off Alexandria, April 1877.

Observations of the 'Times,' May 30, 1877.

There is scarcely any question of greater moment to this country than that which Mr. Brassey—whose return from a very adventurous yachting voyage we announced a day or two ago—discusses this morning in his letter on gunboats. Our national strength is wholly dependent on our naval force, and we ought to watch the improvements and changes in the construction of ships of war as a general watches the daily movements of a hostile force in front of him. We called attention recently to the revolution which seems to be threatened in naval warfare by the development of torpedoes and torpedo-vessels; but, as we then observed, this is but one of the inventions which tend to modify, if not to supersede, the principles by which we have been hitherto guided in the formation of our fleet. These inventions all tend in one direction—that of enabling the most powerful projectiles to be effectually discharged from small vessels. Putting the case thus generally, we include the torpedo-boats; but a not less important application of the same principle was afforded in *Times, May 30, 1877.*

Times. the small gunboats of the 'Gamma' type which were recently despatched to China, and which, as Mr. Brassey informs us, have reached their destination in safety. These little vessels carry each one 38-ton gun, besides two or three small guns; and, by the aid of ingenious but simple mechanism, the heavy gun can be worked at least as effectually as if it were mounted on the huge and expensive gun-carriage provided by the deck of a first-rate ironclad. So far, therefore, as the mere function of carrying guns is concerned, the reason for building large ironclad vessels has ceased. At the same time, it seems placed beyond question that no ironclad can be so effectually armoured as to be invulnerable; and a severe wound inflicted upon such a vessel would, too probably, either send it to the bottom or completely disable it. Such would be the effect, no doubt, of a similar injury upon one of the little gunboats. But whereas in the latter case only one heavy gun, with a small crew, would be lost, in the latter case a battery of heavy guns, with a large number of men, would be sacrificed. Upon these facts the question obviously arises whether it is any longer wise to concentrate our main naval strength in these huge and at the same time delicate vessels.

The urgency of the question is greatly enhanced by one further consideration. Gunboats can be built at a cost which is practically insignificant compared with that of ironclads, and a fleet of them can consequently be provided at the same expense as a single large vessel. For example, as Mr. Brassey puts it, an ironclad like the 'Inflexible' costs half a million sterling; but a vessel of the 'Gamma' type, armed with one 38-ton gun, two 12-pounder breech-loading guns, and one Gatling gun, would only cost 25,000*l.* Consequently we might build twenty vessels of the latter type for one of the former, and while our little fleet of gunboats would mount twenty heavy guns, besides smaller ones, the 'Inflexible' would only carry four guns. Now, what would be the chance of the 'Inflexible' in an engagement with these twenty vessels? It is obvious they would each be liable to be sunk by a single shot from her. But, on the other hand, they would offer but small marks, and by being in constant movement around her they would render it extremely difficult for her to aim effectually. They, meanwhile, would be able to keep up a heavy fire on her from all sides, and they would overpower her in weight of metal by five to one. They would have twenty guns against her four. It would seem, in fact, as if the presumption which formerly existed in favour of large and heavy ships on account of the superior efficacy of their fire is now exactly reversed. In old days a three-decker was the most powerful of ships because she carried a heavier

broadside than any other, and could concentrate a proportionally heavy fire upon an enemy. But the very reverse is now the case. In proportion as our ironclads are effectively armoured the number of guns they can carry is reduced; and for the purposes of the old broadside fire they are far surpassed by a number of small vessels, each carrying its own gun. Doubtless, if we could mount a mass of heavy guns in one impregnable floating fortress, it would be far more powerful than a battery of dispersed naval artillery. But such a monstrous vessel as would be necessary for this purpose would, if built, be practically unmanageable, and, in fact, no one seriously proposes to build one. On the contrary, in one form or another, there is a general consent that smaller vessels are what are needed. The Russian circular ironclads, in which, as will have been seen from a recent letter, Mr. Reed still has confidence, belong, indeed, to the general type of ironclads rather than of gunboats. But they are none the less a smaller type of ironclad, and they are little more than gun-carriages. To judge, indeed, from an account of one of these vessels at Sebastopol contained in a paragraph we published a day or two after Mr. Reed's letter, they are so slightly constructed that they are little better than unarmoured gunboats. Nevertheless, in Mr. Reed's opinion, the presence of two of them suffices to hold the Turkish fleet in check on the only coast of the Black Sea which now enjoys any degree of security. However this may be, these circular vessels are a step in the right direction, and the present Chief Constructor of the Navy has expressed an opinion which is of similar significance. Mr. Barnaby has urged that every monster ironclad should be supported by a flotilla of gunboats. This amounts to a weighty professional opinion that our present ironclad fleet, which is scarcely provided with gunboats or torpedoes at all, is like a collection of men-at-arms of the old days without the archers who were essential to their security. But is it not natural to ask whether, in existing circumstances, the man-at-arms himself is of so very much importance? *Times.*

Mr. Brassey sketches very effectively the conclusions to which these considerations point. At present we build huge ships which are expected to answer every purpose of naval warfare—to carry guns, to act occasionally as rams, and to protect smaller vessels. But for at least one of these purposes, that of carrying guns, they have ceased to be necessary or even desirable. Would it not be wiser to divide, and at the same time to multiply, our forces by constructing different types of ships for different objects? Let us take as a starting-point Mr. Barnaby's great ironclad surrounded and

Times. supported by a flotilla of gunboats. But if the guns are carried on the boats, why should they be carried, at least in the weight and the number now usual, in the larger vessel also? If she were relieved of their weight, she could carry far heavier armour, she could thus be rendered more invulnerable, and she would be more effective as a ram; while she could also act as a kind of floating fortification, behind which her flotilla of movable artillery could from time to time find refuge. She might also carry on board torpedo launches and other auxiliary means of attack and defence. On such a plan, Mr. Brassey calculates, we might for the cost of ten 'Inflexibles' have thirty armoured steam-rams of 2,000 tons each, sixty gun-vessels of the 'Gamma' type, each mounting one heavy gun, and a large equipment of torpedoes. Of course, no one would think of superseding at once the splendid fleet of ironclads we now possess; and it may be desirable always to have a few of them. But it would certainly seem they ought no longer to be, as they are at present, not only our chief, but almost our sole naval arm. A fleet of smaller vessels would be far more handy, far more available in the various waters all over the globe in which our interests might have to be defended, far more easy to multiply upon an emergency, and far less liable to become disabled from mere failure of machinery. The time seems to have come when the case has been fairly made out in favour of some such modification of our system of naval warfare; and it is to be hoped the attention of the Government will be urgently directed to the problem.

THE 'INFLEXIBLE.'

Sir T. Brassey.

Times, Dec. 25, 1877.

SIR,—The report of the 'Inflexible' Committee is the most important document relating to naval construction for war purposes which has appeared since the report of the Committee on Designs. It will probably become a new point of departure in naval architecture, leading to the substitution of shorter ships for the 'Inflexible' type and to the construction of flotillas of those gunboats, the fire from which will, as we are authoritatively informed, be the most effective mode of destroying the larger ironclad. If it lead to the adoption of a policy of distribution of the inevitable hazards of war, as opposed to the concentration of risk in a few ships—a policy which, in common with other naval critics of higher authority, I have long advocated in the *Times* and elsewhere—I for one shall hail the publication of this report with deep satisfaction.

It may, however, be asked whether the special questions which

were referred to the Committee are satisfactorily answered. An examination of the report will show that they are. We are told that the complete destruction of the unarmoured ends of the 'Inflexible' is an extreme assumption; that the process of transition from absolute security to a state in which the efficiency of the ship would be impaired, and her seaworthiness exposed to doubt, must be gradual; and that, while the armoured citadel is not invulnerable nor the unarmoured ends indestructible, the unarmoured ends are as well able as the armoured citadel to bear the part assigned to them in encountering the various risks of naval warfare. *Sir T. Brassey.*

In the judgment of the impartial public, I venture to think, these assurances of the Committee—a Committee most efficiently constituted for the conduct of the investigation intrusted to them—will be accepted as satisfactory. It is not affirmed that the crew of the 'Inflexible' will be exposed to no risk in a naval action; it is affirmed that they will be intrusted with a very powerful instrument of war—one which may reasonably be expected to give a good account of the enemy—long before the unprotected ends are so completely gutted as to compromise the safety of the ship. The gallant captains of the British Navy know very well that, if they are to await the construction of an indestructible ship and invulnerable armour, they will never again be required to undertake the active duties of their profession.

No naval architect has been so ingenious and progressive as Mr. Reed. Our present armoured Navy consists mainly of his productions. But if it is to be laid down that no ship is satisfactory unless she is invulnerable, we shall find ourselves under the painful necessity of condemning all his former designs. The amount of armour which can be carried on a given displacement being limited, the naval architect has to choose between protecting a lesser area by armour of a greater thickness and protecting a larger surface with thinner armour. As it is pointed out in the able treatise of M. Marchal, the process of *décuirassement*, or reduction of the armoured surface, was coeval with the first application of armour to the 'Gloire' by M. Dupuy de Lôme. In his next ship, the 'Solférino,' the armour was removed from the least vital parts, in order to protect the vital places with heavier armour. If the 'Inflexible' has a larger area of unarmoured side than any other armoured ship, she carries heavier armour for the protection of her vitals. The stoutest plates of the 'Inflexible' are 24 inches in thickness. The 'Duilio' is protected by 22-inch plates, the 'Foudroyant' by 15 inches, and the 'Peter the Great' by 14-inch armour.

Sir T. Brassey.

The 'Inflexible' was protected by 24-inch armour on the ground that iron-plating was a useless encumbrance unless it was impenetrable, and that, owing to the progress of gunnery, a less thickness than that adopted was of no avail. If, however, armour of less than 10 inches is no longer recognised as affording any protection against naval guns, what are we to say of the 'Bellerophon,' a great triumph of Mr. Reed's genius? What are we to say of the 'Audacious' class, or the 'Swiftsure' type, protected by 8-inch armour at the waterline, and that for only one-third of their length? And what of other ships, equally vulnerable, on which notwithstanding we place our reliance as integral portions of the Navy? If the 'Inflexible' is to be condemned because she is vulnerable in her unarmoured ends, with much more reason should every ship of older date be condemned. Armoured they may be, but the armour they carry is not proof against the most powerful guns. Being vulnerable, their crews are exposed to risks, and those risks, if we are to accept the arguments directed against the 'Inflexible,' the seamen of the modern Navy ought not to be called upon to undergo.

The truth is the protection afforded by armour is only relatively, and never absolutely, effective. The engagement between the 'Shah' and the 'Huascar' proved the great advantage of armour of the moderate, perhaps in these days contemptible, thickness of 4 inches. By reducing the thickness of the armour the 'Inflexible' might have been protected over a larger area. It cannot, however, be alleged that a superfluous thickness was adopted, and if the surface protected had been increased and an equal thickness of armour had been retained, additional length and displacement would have been necessary. Any modifications in the latter sense it would have been impossible to approve.

It is impossible to secure immunity from risk in battle. All that we can ask from our constructors is that they shall provide the Navy with the most effective ships which the science of the day can contrive. From the administrative heads of the Navy we claim that those ships shall be sufficient in number to secure our maritime ascendency. Our fleets for the line of battle should be composed of large numbers of vessels, each possessing the means of fighting any ship of the enemy with the ram, the gun, or the torpedo, and combining with that destructive power as much protection as can be given without adding unduly to the dimensions, and so depriving our fleets of that advantage, in point of numbers and mobility, which every step in gunnery and torpedo warfare shows to be more and more essential.

In conformity with these elementary principles, I would suggest to the new First Lord of the Admiralty, of whom such high hopes are entertained, that it would be much more satisfactory to complete the 'Inflexible' according to the original design, rather than to attempt any considerable alteration. The extension of the cork chambers and the additional pumping power recommended by the Committee will be valuable improvements not involving any structural change. Beyond these improvements the process of remodelling should not be carried. The Admiralty and the country will know that they possess in the 'Inflexible,' as she is, a most powerful ship—indeed, the most powerful ship in any Navy. The valuable suggestions of the Committee, in reference to reduction of length and increase of beam, can be embodied more economically and more satisfactorily in those new designs which I trust will shortly be matured and carried into execution.

Sir T. Brassey.

Argument for completing 'Inflexible' as originally designed.

In the discussions between Mr. Reed and the Constructors at the Admiralty it is especially to be observed that the security of the 'Inflexible' has been considered solely with reference to artillery fire. No allusion has been made to the far more formidable risks from an attack by the torpedo or the ram. The only defence which the 'Inflexible' possesses against the latter weapons consists in her speed and the facility with which she can be manœuvred. I should, therefore, deprecate in the strongest terms any modifications of the structure of the ship which, while increasing the armoured surface, would have, as a necessary and most regrettable consequence, a diminution of speed. In securing additional protection against the uncertain fire of naval guns, you may expose a valuable ship to grave risks from other weapons.

I conclude with a few observations on the policy of future construction. It is impracticable to produce ships equally adapted to perform all the various duties of the British Navy. We have to provide for the defence of our coasts. We have to hold our own upon the high seas, and to protect our foreign commerce. The best types for coast defence must be determined by local circumstances. Speed is not necessary. Moderate draught is indispensable. The weapon, with which vessels intended for coast defence should be armed, will be in some cases the ram, in others the gun, and in others the torpedo. A certain proportion of the vessels for coast defence should be protected by armour. In all cases they should be of restricted dimensions. A limited coal-supply will suffice. Our Navy is weak in ironclads for coast defence. For ocean cruising, the mastless turret-ship, with sufficiently high freeboard, is the accepted type.

Variety of types required.

Sir T. Brassey.

But every 'Inflexible,' or improved 'Inflexible,' should be the *point d'appui* of a division, composed of armoured rams, armed with one heavy gun, with which should be associated a cloud of torpedo-boats. These latter should lie in wait, beyond the range of the heavy guns of the enemy, ready to rush into the fight after the engagement has begun, and, under cover of the smoke, deal destruction right and left. The Committee point out that the most effective mode of bringing a destructive shell-fire to bear on the 'Inflexible' would be by a flotilla of gunboats concentrating their fire upon her. The creation of such flotillas of gunboats, which should probably be protected by adequate armour against the enemy's fire when in an end-on position, is a pressing necessity. Recent experiences seem to point to the use of steel plates in combination with rolled iron; to the advantages of the dome shape for turrets; and to inverted armour for the protection of the sides of ships.

The task of protecting our foreign commerce has been materially simplified by the opening of the Suez Canal and the more extended use of steam. Our external trade may be divided into four great branches—the East Indian, the China, the American, and the Colonial. The trade with the East is now carried on mainly in steamers of varying tonnage, steaming at moderate speeds. This branch of our trade is most open to attack. To protect it we want a numerous fleet, but the vessels detailed for such a service need not carry sufficient coal for extended ocean voyages, nor do they require such high freeboard as ships intended to steam at speed against the protracted winter gales of the North Atlantic. In the Red Sea vessels of the American Monitor type would be very suitable. They should have low freeboard and light draught, and be able to take advantage of the numerous anchorages inside the coral reefs in the Straits of Jubal and elsewhere, from which ocean-going steamers of deep draught would be excluded.

Protection of commerce on the steam-lanes to the East, and to the United States.

By adopting these moderate dimensions, which the peculiar nature of the service fully justifies, it might be quite possible to establish a continuous patrol along the whole line of that long but narrow bend of sea, on which our trade in steamers with the East and China is concentrated. Small ironclads should be employed on this duty. Though unequal to do battle with such an enemy as the 'Peter the Great,' they would have an overwhelming advantage over unarmoured privateers of the 'Alabama' type and over any merchant steamers temporarily converted into fighting ships.

In time of war it is probable that the Colonial trade would be

carried on in steamers by way of the Suez Canal. They would, therefore, follow the line of the trade with the East in the most exposed portions of the route, where they would be protected by the plan already indicated. *Sir T. Brassey.*

The trade with North America now follows the defined tracks known to Atlantic voyagers as the outward and homeward 'steam-lanes.' If it were necessary, these routes might be patrolled by an armoured squadron of the 'Devastation' type; though the great speed which commercial competition has rendered necessary in the North Atlantic trade would enable such ships as the 'Russia,' or the 'Britannic,' or the 'City of Berlin,' to escape without difficulty from the pursuit of privateers. Men-of-war of the 'Iris' class are not to be found in foreign navies in numbers sufficient to cause anxiety to British shipowners. Vessels of the 'Iris' class are sensibly inferior in coal-carrying capacity to the larger merchant ships. They could not, therefore, be employed in convoying duties, neither could they follow a retreating enemy of nearly equal speed in a long chase in mid-ocean. Our first-class merchant steamers should be sufficiently armed to protect themselves. A considerable number would probably be employed in the Navy in time of war.

Foreign critics on British construction.

As an attentive and impartial observer of contemporary naval administration at home and abroad, I can assure my fellow-countrymen, few of whom have the opportunity of perusing the writings of foreign authors on such subjects, that they may place undoubting confidence in the Constructive Department of the Admiralty. The present constructors, and their able predecessor and now most powerful critic, alike merit the grateful appreciation of the public. We have made mistakes in the past. It is idle to expect that they will be entirely avoided in the future. We are in a situation of exceptional difficulty. We are the first naval Power, and, by reason of our unique and fortunate insular position, the only great Power to which the command of the seas is of vital consequence. The constructors of other navies can afford to await the result of our costly and not always successful experiments. We cannot stand still. When, therefore, we consider that we have been in so large a sense the pioneers in the remarkable and revolutionary changes in the naval architecture for war purposes of the last decade, we have reason to be satisfied that so small a proportion of our expenditure has been thrown away. With the melancholy exception of the 'Captain,' there has been no example of flagrant miscalculation; and it is certain that the catastrophe referred to would not have occurred if the responsibility had not been removed from the permanent staff

Sir T. Brassey. at the Admiralty and divided, in proportions not accurately defined, among many counsellors.

I have the honour to be, Sir,

Your obedient servant,

THOMAS BRASSEY.

Letter of a Flag Officer to the 'Times.'

Flag Officer.

Times, Dec. 27, 1877.

SIR,—In Mr. Brassey's very able and comprehensive letter about the 'Inflexible,' which you inserted on the 25th, there are, I think, two or three points on which naval officers will differ from him.

He says: 'For ocean cruising the mastless turret-ship, with sufficiently high freeboard, is the accepted type.' Accepted! By whom? Certainly not by those who know what it is to be thrown into the trough of the sea in a gale of wind, which would inevitably be the case with a mastless steamer, either short of coal or with disabled engines or steering gear.

Again, 'The Committee point out that the most effective mode of bringing a destructive shell-fire to bear on the "Inflexible" would be by a flotilla of gunboats concentrating their fire upon her.' I dare say it would; but can it be supposed that the 'Inflexible' would, in these circumstances, be motionless? In old times frigates were occasionally becalmed near an enemy's port, and were then attacked by gunboats with advantage; but such a thing is hardly possible with a steamer. Of course, a steamer may be disabled and motionless, but in that case a ram or a torpedo would settle her more effectually than a flotilla of gunboats.

Mr. Brassey also speaks of gunboats being 'protected by adequate armour;' but gunboats can only carry comparatively thin armour, which may, or may not, afford adequate protection, according to what guns are opposed to them. Protection for gunboats from the 'Inflexible's' guns is out of the question.

For ocean cruisers fuel stowage is the great *desideratum;* and in this respect we have made less advance in the last forty years than in any other particular. 'Your coals will be like gold dust,' was the *dictum* of one of the ablest officers the Navy ever possessed.

I am, Sir, your obedient servant,

FLAG OFFICER.

THE 'INFLEXIBLE.'

SIR,—While thanking 'A Flag Officer' for the courteous terms in which he refers to my recent letter in the *Times* on the subject of the 'Inflexible,' I observe that a question is raised as to the acceptance by the naval profession of the 'Devastation' type for general service at sea. In reply, may I be permitted to say that, as a civilian, I should not venture to put forward any original views on such a subject? In justification, therefore, of the statements to which exception is taken, I quote the following authorities.

Sir T. Brassey.

Times, Jan. 2, 1878.

The 'Devastation' class, including at the date of their report the 'Dreadnought' and the 'Thunderer,' to which the 'Inflexible,' 'Ajax,' and 'Agamemnon' have been since added, were unanimously approved by the Admiralty Committee on Designs for Ships of War. They say:—

Mastless turret-ships.

'From the information furnished to us by their Lordships' commands, we learn that these ships were designed for service in European seas, including the Channel and the Mediterranean, the prospect of being required to cross the Atlantic being also contemplated.' . . . 'We are unanimously of opinion that, subject to any improvements which further investigations may render possible, the "Devastation" class represents in its broadest features the first-class fighting ship of the immediate future.'

These views were in strict accordance with the opinions of officers of the greatest experience in command of ironclad fleets.

In his report on the experimental cruise of the Channel Fleet in 1866, Sir Hastings Yelverton directs the special attention of the Admiralty to the advantages of the turret system for working the guns in heavy weather, when a 'sea-going turret-ship 12 feet or 14 feet out of water could fire easily six shots to every one from the broadside ships.' The adoption of the turret system involves the reduction of masts and sails to such small proportions that canvas can no longer be relied upon for handling large ironclads. The all-round fire, one of the greatest advantages of the turret system, is seriously interfered with in fully-rigged ships.

On the masting of ironclads.

The impossibility of handling an immense ironclad satisfactorily under sail alone is clearly shown from the reports of the captains of the Channel Fleet on the behaviour of their respective ships in a severe gale off Cape Finisterre in December 1868. Captain May, of the 'Northumberland,' said:—

Sir T. Brassey.

'In my opinion, this vessel, when caught in a heavy gale, should, if possible, get up steam at slow speed; the square sail should then be furled, the after-trysail set, and the ship's head placed with the sea three points on the bow.'

Lord Gilford was in command of the 'Hercules' in another gale off Cape Finisterre. In describing the performance of his ship, which he highly commended in other ways, he said that 'she steered so widely, and broached to so often, that he gave up the idea of running out the gale, and hove to with trysails, using steam.' The inference to be drawn from this report is that if the 'Hercules' had been deprived of the use of her engines and had fallen off into the trough of the sea, it would have been difficult either to scud or to bring her to the wind under sail alone. Sail, therefore, while adding most materially to the efficiency of the 'Hercules' as a cruiser, cannot be regarded as indispensable for the safety of the ship.

The impossibility of handling ironclads under canvas in circumstances of difficulty was strongly insisted upon by Sir Sydney Dacres in his evidence before the Committee on Designs. He said that though there was great advantage in the power of a masted ironclad to keep an assigned station in the open sea without using coals, it was not possible, masts or no masts, to do it in the Channel. He could not call ironclads sailing ships at all; 'there was no sailing in them.'

Sir Thomas Symonds, another witness called by the Committee, concurred in this view. He doubted the possibility of a ship displacing 9,000 tons sailing well even with a lifting screw. Sails could scarcely be given her of proportionate size. The ballast carried by some ships, simply that they might carry enormous masts, involved a great and useless sacrifice. For a Channel fleet, and any fleet which could be trusted in the Channel would be equally adapted to defend our interests in the Mediterranean, Sir Thomas Symonds recommended double-turret ships lightly masted.

Sir Spencer Robinson, who was also examined by the Committee, said that, if reconstructing the fleet from the beginning, he would build two distinct classes, one moderately masted for service in any part of the world, the other unmasted for service in Europe. Mr. Reed, too, was of opinion that the 'Devastation' type should be employed, rather than masted ships, for all great operations within 3,000 miles. Masted ships would be required for distant stations, but all European work, even blockading, could be done by unmasted vessels.

In citing the foregoing recommendations in favour of unmasted

vessels, I submit that I have shown ample authority for the selection of the type so specially approved by the Committee on Designs. The term 'mastless' did not, I assume, imply the exclusion of two reduced masts, as proposed by Sir Thomas Symonds, for setting try-sails to steady the ships, and show a bold weather side to the wind and sea. *Sir T. Brassey.*

In recommending lightly armoured rams, gunboats, and torpedo-boats as valuable adjuncts to a fighting squadron, I am again only following the opinions of Sir Spencer Robinson and other able officers. Gunboats, or rams of under 2,000 tons, with or without guns, cannot, it is true, be protected by armour which would keep out the shot from an 80-ton gun; but it is to be remembered that those guns would be few in number, even on board the largest ships, and their fire would be slow. In the smoke and excitement of battle small swift vessels would have a good chance of avoiding a few very heavy projectiles, and their light armour would afford protection against Gatling guns, 40-pounders, or other light guns, which might be advantageously multiplied in large ships for the special purpose of repelling the attack of small vessels. Lightly armoured gunboats have been introduced in the French, German, Spanish, Turkish, Dutch, Swedish, Argentine, and Brazilian Navies; and torpedo-boats, protected against musketry and Gatling guns, are to be found in the Italian and German services. **Auxiliary vessels.**

It may be observed, in conclusion, that on all questions of ship-building for war widely divergent opinions prevail among those most competent to advise. The intervention, therefore, of laymen may not be altogether unnecessary in assisting to settle disputed points, which can only be decided by unprejudiced and unbiassed minds.

I have the honour to be, Sir,

Your obedient servant,

THOMAS BRASSEY.

Letter of a Flag Officer to the 'Times.'

MASTLESS IRONCLADS.

SIR,—Mr. Brassey's letter which you inserted yesterday is most gratifying to me, for he gives extracts, which I had not seen before, from sundry reports of very distinguished naval officers, whose views respecting mastless ironclads entirely coincide with my own. *Flag Officer.* *Times, Jan. 4, 1878.*

I maintain that, for cruising ships likely to meet heavy weather and to be at sea an indefinite time, sail is indispensable; and I also

Flag Officer.

maintain that it is perfectly possible to give double turret-ships, without masking their all-round fire, a sufficient spread of canvas to prevent their being driven helplessly on a lee shore or rolled over in the trough of the sea, if disabled in a gale of wind.

No one, I imagine, would now propose a full-rigged turret-ship. We bought our sad experience in that matter much too dearly; but I do say that if they are to be used for 'ocean cruising' they should be, as Sir Thomas Symonds recommends, 'lightly masted.'

'Mastless,' I apprehend, means without masts; and I do not understand that term to 'exclude two reduced masts for setting trysails to steady the ship,' and which would enable her to keep the sea on her bow.

Our thanks are due to Mr. Brassey for ventilating this subject, on which it is quite true that 'widely divergent opinions' exist. I am, however, quite content to row in the same boat with the officers he quotes, none of whom, I am quite sure, would care to be in a disabled mastless turret-ship during the height of an Atlantic gale.

Your obedient servant,

FLAG OFFICER.

THE 'INFLEXIBLE.'

Sir T. Brassey.

Times, Jan. 12, 1878.

Arguments against extensive structural alterations in the 'Inflexible.'

SIR,—In a former communication I recommended the completion of the 'Inflexible' in accordance with the original designs. The report of the Committee seemed abundantly to justify the Admiralty in adopting such a course. It is not denied by the Committee that the 'Inflexible' would be unsafe if her unarmoured ends were destroyed; but we are told by naval officers, who on such a question are the most competent advisers, that the contingency of the complete destruction of the unarmoured ends of the ship is in the highest degree improbable. Absolute safety in naval battles no constructor can pretend to insure.

It is possible, however, that on further consideration a decision may be taken to increase the stability of the armoured citadel of the 'Inflexible.' In view of such an alternative, I venture to remonstrate in the strongest terms against any considerable addition to the outlay on the ship. The 'Inflexible' represents already a larger proportion of the naval resources and expenditure of the country than it is desirable to concentrate in a single unit of the fleet. If, therefore, any alteration should be decided upon, I would suggest a reduction in the thickness of the armour on the sides of the turrets of the ship. Even though the thickness of the armour be reduced

from 24 inches to 18 inches, or 12 inches, the 'Inflexible' will be strongly protected, while the four 80-ton guns, the ram, and the large coal-carrying capacity of the ship present a combination of offensive power which must always render her a grand addition to our fighting Navy. *Sir T. Brassey.*

I have before suggested in the *Times* that an administrative error has been committed in the development of our recent ship-building policy. The ingenuity of our constructors, and the money available for naval construction, have been developed too exclusively to the strengthening of the fleet for defensive rather than offensive warfare—to increasing the thickness of armour rather than the multiplication of guns, rams, and torpedoes.

It was only the other day that it was reported that a swarm of torpedo-boats was in preparation at Fiume, for the purpose of driving our ironclads out of the Bosphorus. We have been debating whether the 'Inflexible' can carry 24-inch armour. Setting aside the question of stability, would it not in any case have been wiser to be content with somewhat thinner armour, and to have spent the money saved on armour-plates in creating that flotilla of torpedo-boats, without which, in these days, it would scarcely be prudent to send a fleet of heavy ironclads into confined waters?

In an able article against the design for the 'Inflexible' which appeared in *Engineering* on the 28th ult., an argument is urged, which seems to me decisive, in favour of that reduction of armour which would be the least expensive method of increasing the stability of the ship. The writer is of opinion that the unarmoured ends should have been defended with armour of moderate thickness, and not left as at present, wholly unprotected. He truly says that it is a great error to assume that it would be as easy to penetrate armour at sea as it is to penetrate a target at Shoeburyness. 'If the gun and the target are equally matched at Shoeburyness, the chances are all in favour of the armour at sea. Owing to the difficulty of striking the armour fair, or at right angles, the chances of the shot penetrating are extremely remote; and it is impossible to send a shot through containing a heavy bursting charge.'

This argument, if good in favourof light armour on the undefended extremities, also justifies a slight reduction in the armour which protects the centre citadel. Armour of less thickness than that now proposed would afford considerable protection against the heaviest fire which the 'Inflexible' is likely to encounter. I do not contemplate the extensive introduction of 100-ton or 80-ton guns into the naval service. Protection against guns of less calibre is of great importance.

Sir T. Brassey.

We desire that the citadel should be absolutely secure, if possible. But a reduction in the weight of armour in the present case should be accepted, if any doubt exists with reference to the stability of the 'Inflexible.'

Continual alterations in ships in construction, in the vain hope of bringing the designs of past years to the level of the latest ideas in a time of rapid transition, have contributed with other causes to that delay in the production of fighting ships which, when we compare the relative growth of the German and the English Navies, and the annual expenditure on the two services, is so exceedingly unsatisfactory to the British taxpayer.

Once more I urge the adoption in the case of the 'Inflexible' of such an alteration—if any be necessary—as can be effected at the lowest cost. I do so, not only because it is impolitic to spend more money on a ship which has already cost so much, but because I share in the general feeling of impatience to see several ships laid down of broader beam, with finer ends, and a larger area of protected surface in proportion to the total displacement, and having more stability within the armoured citadel. These are the principles advocated by Mr. Reed, by the writer in *Engineering*, and by Admiral Hope's Committee. They can be developed in new designs in far more perfect form than in the unsatisfactory yet costly attempt to alter the construction of a ship designed on a different principle, and now approaching completion.

I am, Sir, your obedient servant,

THOMAS BRASSEY.

THE LOSS OF THE 'GROSSER KURFÜRST' AND ITS LESSONS.

Times, June 5, 1878.

SIR,—The people of England will sincerely lament the loss of life and the destruction of a noble vessel, which have resulted from the recent collision between two ironclads of the German Navy. Our own disasters will make us the more sensible of the calamity which has befallen a neighbouring and friendly Power. But while we sympathise we must not neglect the lesson such an incident conveys.

Training of the Navy.

1. First, as regards the *personnel*. The loss of the 'Grosser Kurfürst' is in part attributable to inexperience. Your correspondent, in his able letter, informs us that the German ships are at all times less than half the distance apart which is thought advisable for British ships. It is certain that the dangerous consequences of the German system would have been discovered long ago, if their

squadrons had been more frequently at sea, and their officers had been more familiar with the varied and often unforeseen emergencies incidental to navigation in the crowded waters of the English Channel.

Sir T. Brassey.

It can scarcely be maintained that an ironclad under steam is more difficult to handle than the old line-of-battle ship under sail, but the consequences of a collision are far more serious, and the ships of the present day, from motives of economy, remain too long in port.

In making passages under sail there is an expenditure of money in ropes and canvas, which probably amounts in the aggregate to a sum little inferior to the cost of the coals consumed in a similar passage under steam. But the wear and tear of ropes and sails is an indirect charge, which escapes notice until the ship is refitted at the end of a long commission. The cost of coals is a direct charge immediately felt. Hence comes a tendency to limit the movements of ironclad ships to those comparatively rare occasions when ambassadors and consuls require a display of naval force on a new scene. Owing to these long periods of inactivity ironclads are not sufficiently at sea to enable their officers to gain experience in handling the enormous ships which are intrusted to their care. Let it be remembered that it is not enough to appoint experienced captains. Every officer, who may be called upon to take charge of a watch, ought to be master of his profession, and every sub-lieutenant should be daily improving in that seamanlike aptitude and resource, which can only be developed at sea.

Argument against ships of extreme dimensions.

2. The loss of the 'Grosser Kurfürst' may be claimed as an illustration—and it is a very striking one—of the necessity for the distribution of the inevitable risks of naval operations among a large number of ships of moderate tonnage. To concentrate our naval power in ships as huge and unwieldy as some of those which have lately been constructed would prove a mistaken policy if we were brought face to face with the practical exigencies of war. If the 'Grosser Kurfürst' had been a shorter and a handier ship, she might possibly have turned under the port helm in time to avoid the crushing blow of the 'König Wilhelm.' If the latter had been less gigantic in size, she might have been kept clear of her unfortunate consort.

The destruction of the 'Vanguard' and the 'Grosser Kurfürst' have shown that the ram is the most terrible of naval weapons. The power to strike, or to avoid a blow, will depend on the speed and evolutionary qualities of the ships engaged in combat. Given equality in cost and tonnage, that fleet will be the most formidable

Sir T. Brassey. which contains the greatest number of rams, moderately protected and thoroughly seaworthy. Ships of from 9,000 to 12,000 tons will use the ram with less effect than vessels of half their dimensions. Evolutionary qualities will be more essential than thick armour or heavy projectiles. The alternatives of victory or defeat will depend more than ever on the personal skill and daring of the commanders.

It is proved, from the damage inflicted upon the 'König Wilhelm,' that the use of the ram involves no inconsiderable risk even to the ship which makes the attack. In squadrons composed of a limited number of costly ships, officers in command will grow hesitating and cautious in a mode of warfare in which caution and hesitation are fatal to success. Is it likely that a captain will enter the lists with all that contempt for consequences by which the greatest naval battles have been won, when he knows that the ship under his command represents a large fraction of the combined naval strength of his country? In concentrating our power, as we have lately done, we impose too severe a strain on that sense of responsibility of which a naval officer cannot, even in action, wholly divest himself. We ought to relieve our commanders of an undue weight of anxiety, by so increasing the numerical strength of our squadron that the loss of a single ship will cease to be an overwhelming disaster.

Necessity for auxiliary vessels.

I am not urging these views for the first time on the attention of the naval authorities and the public. I worked with my lamented friend Mr. Graves in asking for small vessels, gunboats, rams, and monitors for the defence of our harbours. Little has been done as yet in answer to our appeals. Following in the line in which Mr. Barnaby himself has led the way, I have again and again urged the Admiralty to provide a flotilla of torpedo-boats to protect our larger ironclads from the swarm of assailants which might be brought against them—liliputian, perhaps, in point of size, but armed with that most dreaded engine—the torpedo.

Mr. Reed has reminded us that effective weapons of offence can be multiplied in considerable numbers by Powers which could not afford the expenditure we incur on our 'Dreadnoughts' and 'Inflexibles.' The deficiency in torpedo-boats, so obvious a source of weakness in our squadron in the Sea of Marmora, has happily been made good, while the Russians have experienced difficulties in procuring similar vessels with equal promptitude. It is only very recently, however, that the gallant Admiral who commands in the Mediterranean, and the Admiralty at home can have been relieved from a painful anxiety, which would never have been felt if more thought

had been bestowed in time of peace on the small but indispensable auxiliaries of a modern fleet. *Sir T. Brassey.*

The advocates of smaller vessels of special types have always admitted that a first-rate naval Power must have squadrons of ocean-going ironclads, in order to maintain the command of the seas; but they have contended that the auxiliary vessels of special types should find a place in a well-considered and comprehensive programme of construction.

When the Naval Estimates were introduced at an early period of the present Session, the types of the ironclads which it was proposed to commence had not been definitely settled. Meanwhile, the lessons taught by passing events will not be lost upon the Council of Construction. We shall doubtless see, in a return to more moderate dimensions even for the line of battle, and in the multiplication of types for special services and for the independent use of the different arms of the Navy, that we have profited by a chequered experience, that we have gathered in a riper wisdom, and that we are not prejudiced nor hampered by ancient traditions.

I am, Sir, your obedient servant,

THOMAS BRASSEY.

THE ITALIAN IRONCLADS.

Times, March 14, 1879.

Criticisms on the large ironclads of the Italian Navy.

SIR,—Before the echoes of the recent debate in the House of Commons on the Naval Estimates have finally died away, I venture to ask the privilege of giving to the public, through your columns, some additional information respecting the formidable ironclads now approaching completion in the Italian dockyards. While the efficiency of the Navy is of the first importance to England, the subject receives comparatively little attention, chiefly because the sources of information are difficult of access.

It is not at present in contemplation at the Admiralty to follow the Italian constructors in building ships of extreme dimensions; but public opinion, always so susceptible on the point of our naval supremacy, and so imperfectly acquainted with the means by which it can best be secured, may perhaps hereafter exert a pressure in the direction taken by Admiral San Bon.

What, then, are the distinguishing features in the design of the 'Italia'? The ship may be described as a raft formed by two armoured decks, the upper deck being five feet above and the lower eight feet below the water-line. The space between the decks is

Sir T. Brassey.

divided into a number of watertight cells, filled at the sides with cork. In the centre of the raft body a citadel is constructed, protected by armour, and containing two fixed turrets, in which the guns are mounted *en barbette*.

There is much to admire in the details and even the leading features of the 'Italia'; but, considering that side-armour has been boldly given up, and that the great dimensions of the 'Inflexible' were adopted, with all their attendant disadvantages, solely with the view of carrying an increased weight of armour on the side, I cannot think that the Italians are wise in building such large ships.

The design has, however, been defended, on the ground that it insures an invaluable superiority in regard to coal endurance. Let us follow up this argument. It is admitted that ships of 8,000 tons can be built capable of attaining the same speed as the 'Italia,' and with a marked improvement in evolutionary qualities. Let us suppose the ram is resorted to. In that case it can scarcely be disputed that victory will incline, *cæteris paribus*, in favour of that fleet which has an advantage in point of numbers of two to one, the more numerous ships being as superior in evolutionary qualities as in numbers. With an equal expenditure, therefore, an unquestionable superiority for battle will be secured with ships of the 'Agamemnon' and 'Colossus' types, as compared to the 'Italia.'

It is, however, argued that the 'Italia,' having the advantage in coal endurance, might decline battle, steam away from the smaller ships, bombard our undefended ports, and intercept our commerce. The *rôle* of the 'Italia,' in short, is to be that of the 'Alabama'; but while the former will cost 750,000*l.* the latter was probably built for one-twentieth of that amount.

Types recommended by Captain Colomb, R.N.

The principles by which our policy of naval construction should be guided have been clearly stated by Captain Colomb in the prize essay of last year. Looking to the fleet as a moveable force, he maintains that it should be the main object to secure to the utmost degree the power of concentration and the power of dispersion. The policy of the naval constructor must be based on this primary strategical principle. Applying this principle to the individual ship 'Inflexible,' it may be asked, Does such an accumulation of expenditure on a single vessel represent the greatest power of concentration and dispersion over the area within which our naval forces are to act? Viewed in this way, and assuming that the object of strategy is to insure the right force being at the right time in the right place, Captain Colomb would, as a matter of sound policy, increase the

number of ships rather than attempt to gain technical results satisfactorily in one ship by the sacrifice of strategical qualities. *Sir T. Brassey*

I rejoice that these principles have prevailed in the latest decisions of the Admiralty in respect to shipbuilding. The four largest ships now in construction are under 9,000 tons, and the 'Conqueror' seems especially designed to meet the suggestion put forth by Chief Engineer King, of the United States Navy, at the conclusion of his description of the 'Inflexible.' It was, he said, a question whether two vessels of smaller dimensions, each carrying two 80-ton guns instead of four, would not have been a safer and a better investment.

The advocates of modern dimensions do not desire to cut down estimates, but to divide the inevitable risks of naval warfare, and to secure for our fleets and squadrons that superiority in numbers and in evolutionary qualities which is of primary importance for the effective use of the ram, and as a defence against the torpedo.

I am, Sir,

Your obedient servant,

THOMAS BRASSEY.

Letter from Signor Mattei to 'Times.'

Signor Mattei.

Times, April 15, 1879. Efficiency of the 'Italia' for the destruction of commerce.

SIR,—I shall be deeply indebted, should you be so kind as to give admission to these few lines, in answer to the letter of Mr. T. Brassey, M.P., published in the *Times* of the 14th inst., under the title of 'Italian Ironclads,' specially with the object of disclaiming the piratical intentions attributed to us in the building of vessels of the 'Italia' class, in the passage of his letter concluding with the following words: 'The *rôle* of the "Italia," in short, is to be that of the "Alabama."' Setting aside any criticism on the description of the 'Italia' given by Mr. Brassey (it would not be a hard task to point out several mistakes in that part of his letter), and heartily thanking him for the compliment he has paid to us in saying that there is much to be admired in the details and even in the leading features of the said vessel, I come at once to the point. It can be admitted without question that if a vessel of that class were to be employed against the merchant navy of any enemy, she would be found extremely well adapted for that sort of service. Possessed of a high rate of speed, which would deprive her intended prey of nearly all possibility of escape, endowed with an amount of military power which would make it very difficult to dislodge her from the waters where she had judged expedient to operate, unapproachable by any

Signor Mattei.

vessels of the class now styled cruisers, it may be surmised she could inflict a great deal of damage, before an overwhelming force came to the rescue; and even in that case it would go hard with her if she suffered any damage, beyond being obliged temporarily to shift her ground of operations. But, after all, pillaging, scuttling, and ruining innocuous merchantmen would be a most miserable sort of war; cruel, without leading to any decisive results, repugnant to our feelings, and to which we should never resort but under the pressure of absolute necessity; and I do not think it fair to bring against us the accusation (unwittingly, it may be) of having designed our new class of vessels for this purpose, however well they may be adapted for it, while they are admittedly endowed with capabilities of quite a different order, and (from our point of view) of far greater importance.

Maritime defence of Italy.

To explain in any degree clearly our intentions in designing these vessels, I am sorry (for the reader) I must have recourse to a bit of retrospective history. It is not so many years ago that one of the questions of the day for the young kingdom was, whether the keeping of a war Navy was a useless luxury or a real necessity—a question which it was in the interest both of the Navy and of the nation at large to get resolved with the least possible delay. At that time the conditions of national defences were under consideration, and the result of many deep and anxious researches was this—that our War Office could put at any given moment (with the delay necessary for mobilisation) on our land frontier an army of 300,000 men in the first line, which, considering that on two large sections of that frontier we are conterminous with two of the greatest military Powers of Europe, is certainly not one man too many; but that, at the same time, it could not spare any significant force for the protection of our maritime frontier, and that part of the national defences should be understood as devolving upon the Navy.

Now, as to the extent of our sea frontier, a single glance at a map of our peninsula is quite sufficient to give an idea of it; as to its conditions for defence, they are, it may well be said, known to everybody. Italy is surrounded by a deep sea, mostly without difficulties and dangers. In many parts ships may approach so as almost to touch with their yards the trees and houses on the shore; above all, on the average, during a great part of the year the sea is as calm as any lake. A great number of our largest towns—Genoa, Leghorn, Naples, Palermo, Messina, Catania, not counting a large number of second-rate towns and boroughs—are placed in close proximity to the sea, so as to render it impossible, without an impracticable

expense, to provide for their defence with land fortifications against the present means of naval attack. Signor Mattei.

Nor is this all. Along our Tyrrenian, Ionian, and Adriatic shores there are railways and roads, in many places quite close to the water's edge, forming the principal longitudinal connection between the different parts of the peninsula; to this must be added that there are numerous spots where landings might be effected, and our most important military communications menaced, interrupted, or even taken advantage of for further land operations. It may easily be conceived that with such an extent of coast, and under such conditions, the defence by naval means of our sea frontier was a problem of very difficult solution. Some consideration of the subject soon convinced us that the attainment of absolute safety for our seaboard was out of the question; all we could hope for was to obtain means to disturb, to interrupt, perhaps to render nugatory, any large operation of the enemy in view of a landing or of a bombardment, by dividing the attention of the protecting force, causing it to shift its position, and consequently allowing us to make use of our secondary means against the floating material necessary for such operations. In this very peculiar case, it was hardly to be expected we should enter into an academical discussion, concerning in the abstract the power of concentration and dispersion, with the serenity of a prize essay, such as Mr. Brassey relies upon for his authority. After a careful study, we came to the conclusion that the best vessels for that purpose would be such as might be capable of making the greatest impression on any given point—in other terms, vessels, which in the proximate future should not be exposed to meet an individual enemy of superior offensive and defensive power, indeed, hardly an equal one. Upon these considerations the 'Duilio' was designed.

Later on we felt serious misgivings that ships of that design were rather deficient in speed and coal endurance, and that their arrangements precluded giving to them a subsidiary armament of smaller guns, such as we considered very important for protection against torpedo-boats and other small craft, which may be expected to take part in such actions as we were providing for. To make good these deficiencies, adhering still to the main features of the 'Duilio,' would have been putting more eggs into the one basket, already rather overcharged; and, consequently, not without much hesitation, and after a careful weighing of profit and loss, we decided upon doing away with a considerable part of the casing, and that brought us upon the design of the 'Italia.' Such is the plain and unvarnished history

Signor Mattei.

of that design, from which, I hope, it will be clearly seen that she was from the beginning intended for the same purpose as the 'Duilio' —a very legitimate purpose, let me add, that of protection to the doors and windows of our own house, and not for any piratical expeditions, of which Mr. Brassey has most gratuitously attributed to us the intention. After having removed the stigma of intended piracy, brought against us by Mr. Brassey, it is hardly worth while to controvert the judgment he was pleased to pass upon us concerning our wisdom or rather unwisdom, in our present shipbuilding policy, merely adding that Mr. Brassey's opinion on that point leaves us completely undisturbed. If we had wanted opinions, we have the honour of being acquainted with several of the gentlemen in the Constructive Department of the British Admiralty, for whose talents and attainments we entertain the deepest respect, whose opinions would be most highly valued by us, and it is a great satisfaction for us to see that they have never joined with the amateur naval architects in their criticism upon our doings; in fact, being themselves rather frequently disturbed from similar quarters, it is easily understood that they have no inclination to indulge in that sort of pastime.

I remain, Sir, your obedient servant,

F. MATTEI,

Inspecteur Général du Génie Maritime
(Marine Royale Italienne).

THE SIZE OF IRONCLADS.

Sir T. Brassey.

Times, May 13, 1879.

SIR,—I do not desire to enter into a controversy with Signor Mattei. Allow me, however, to observe, in reply to his letter recently published in your columns, that I have never asserted that the Italian constructors have themselves suggested that their monster creations should be used to do the work of an 'Alabama.' I said that the construction of similar ships had been recommended for our own Navy, the chief point insisted upon being their superiority in respect to coal endurance over ships of a tonnage not exceeding that of the 'Dreadnought.' Signor Mattei is unable to deny the inferiority of a ship of 14,000 tons to one of 10,000 tons in manœuvring qualities. He must admit that those are qualities of vital importance in an encounter with the ram. But he thinks that inferiority in this regard is amply compensated by the superior coal endurance obtained in the larger ship.

Signor Mattei repudiates the notion that the 'Italia' would be employed to cut up the commerce of an enemy, and he informs us that the four huge ships now building for the Italian Navy are intended for coast defence. If this be the aim, it affords an additional argument against their enormous tonnage. In proportion to the increase in tonnage beyond a certain limit a ship becomes less effective for the use of the ram, and fleets and squadrons are numerically weaker. The only gain is in coal endurance, to the point, as it is alleged in the case of the 'Italia,' of being able to carry coal enough to steam round the world. With these facts before us, is it not evident that the Italians have sacrificed power for battle to superfluous coal endurance? Signor Mattei can scarcely contend that in a ship of the same type as the 'Italia,' but not exceeding 9,000 to 10,000 tons, there would have been any difficulty in carrying an adequate supply of coals to navigate in the Mediterranean, and to defend the coasts of Italy.

In order to illustrate my argument, I will assume an encounter between two hostile fleets—the one composed of four ships of 15,000 tons and the other of six ships of similar type, but of the less exaggerated dimensions of 10,000 tons. I assume further the attack to be made with the ram. Such being the conditions of the engagement, I appeal with confidence from the constructors to the officers who have to fight our ships, and I ask whether the chances of victory are not decidedly in favour of the fleet which has a superiority in numbers, the six ships of which it is composed being individually more formidable, because more readily manœuvred, than their larger antagonists.

Signor Mattei writes disparagingly of amateur naval architects. I make no pretensions to professional or scientific attainments. When, however, we hear these questions so warmly debated between experts, and when we find the officers, who have experience in battle —the men who fought at Lissa and those who went through the long ordeal of the Civil War in America—unanimous in their objection to a policy of shipbuilding which would reduce our fleets to a miserable insufficiency in numbers, the attention of a civilian may not be ill-bestowed in listening to the arguments on both sides, and in endeavouring to form an impartial judgment.

You have given publicity to the letter of Signor Mattei. I ask the privilege of inserting a letter from Hobart Pasha. It is the only letter I have received on the subject, and it gives a widely different, and, I believe, a more practical view than that advocated by your Italian correspondent.

In conclusion, I desire once more to express my admiration of

Sir T. Brassey. the skill displayed in the Italian ships, their main fault being their excessive dimensions.

I am, Sir, your obedient servant,

THOMAS BRASSEY.

'Constantinople, March 23, 1879.

Hobart Pasha. — *Times*, May 18, 1879.

'MY DEAR BRASSEY,—I was so glad to see your letter in the *Times* about large ships to be used for fighting purposes, because it so thoroughly accords with my humble opinion on the mattter. I am sure that you are right. What we want are small, heavily armed, fast vessels, that can, as it were, "hop round their enemy like a cooper round a cask," hitting him on every vulnerable point, shelling his decks at long range, and worrying him to death. I hope that you will continue to maintain the ground that you have taken up.

'Of course, the small vessels would be liable to a hard knock now and then; but you cannot go to war in kid gloves.

'As to bombarding forts, rely on it, in these days of 35-tons in masked batteries, or batteries cased with 30 inches of iron, the idea is obsolete—no sane man would think of such a thing. Fleet's guns can only be used against land defences in making a diversion while landing troops. Remember also the immense cost of losing by torpedoes or otherwise one of the new monsters such as Italy has built.

'No; stick to the idea of small vessels, and common sense must bear you out to the end. If you can find the *American Review* of November last, you will see my humble opinion on naval warfare of the future.

'Faithfully yours,

'HOBART PASHA.'

RECENT DESIGNS FOR SHIPS OF WAR.

Sir T. Brassey. — From *Macmillan's Magazine*, August 1877.

An opinion may perhaps be entertained in many quarters that professional critics are alone competent to discuss the shipbuilding policy of the Navy. A distinction should, however, be drawn between questions of constructive detail and questions of general policy. In regard to the former, experts alone can express a competent opinion: on the general question, common sense is no untrustworthy guide. The perplexity of the subject is increased by the unfortunate circumstance that the opinions of the experts themselves are often diametri-

cally opposed; and, as the controversies that are raised are of the gravest national importance, it becomes necessary for the public to form for themselves an independent conclusion. *Sir T. Brassey.*

I take as an illustration the discussions on the expediency of retaining armour, and the relative power of the gun, the ram, and the torpedo. In the British Navy there is an almost hopeless conflict of opinion. In an essay, to which the prize of the United Service Institution was recently awarded by three distinguished admirals, Commander Noel specially insists on the importance of avoiding excessive top-weight, and so securing a sufficient margin of stability to enable an ironclad to continue seaworthy, even though partially waterlogged from injuries received in action. He considers this point so important, that he recommends the abandonment of armour for the protection of the battery. An opposite view is expressed in an able letter which I have received from an admiral in a high command. The writer is of opinion that our men would have no chance in an unarmoured ship if they had to contend against heavy guns, protected by a turret, and therefore fired with confidence and precision.

The painful uncertainty in which we are placed in this country is, however, shared by every maritime Power. Impressed with a conviction of the impracticability of resisting the fire of the heavy guns recently introduced, many naval authorities have advocated the abandonment of armour as a useless and costly encumbrance. In his able work, *La Marine Cuirassée*, published in 1873, M. Dislère, of the Constructor's Department of the French Navy, said, 'The armoured sea-going cruiser is in our judgment an obsolete type.' The predictions of M. Dislère are almost justified by the course of events in naval construction. The 'Inflexible' is protected by 18-inch armour, and the Italian ironclad, the 'Dandolo,' by 22-inch armour. When the progress of gunnery shall have rendered 22-inch armour insufficient, Messrs. Cammell undertake to roll plates of 30 or even 40 inches. 'For the moment,' as it was observed in an article on these vessels in the *Times*, 'the advantage seems to be in favour of armour; and yet a target, representing the strongest portion of the armour of the "Inflexible," was penetrated at 1,800 metres by a Krupp gun.'

While we find an eminent French authority announcing that armour will shortly be laid aside, Admiral Porter, in his report, published in December 1875, said that the aim of the United States should be, in making changes, to resist the shot from the 12-inch 35-ton gun, which at 200 yards perforates 15 inches of solid wrought iron. He asked for twenty-four first-class ships; but such vessels

Sir T. Brassey. would represent, in his opinion, no decided power for offence or defence, unless they carried sufficient thickness of armour to resist the average rifle gun, and had speed to get within striking distance of the enemy. 'Wooden vessels,' he observed, 'add nothing to the fighting force, just as, in former days, engagements fought with frigates never materially affected the result of war.'

In his essay, published in the present year, entitled *La Guerre d'Escadre*, M. Dislère somewhat modifies the opinion he had previously expressed. He says: 'The aim has been, with the mastless ironclads, to produce a ship of war unsinkable by the fire of the enemy, and capable of fighting its guns to the last. Everything has been sacrificed to that idea. Due regard has not been paid to the effect of the new weapons, the terrible effect of which was revealed during the American War of Secession and at the battle of Lissa. Against the ram, and against the torpedo, the Colossus of the seas, of from ten to eleven thousand tons, loses the advantages so dearly purchased; and the ironclad ship, protected by armour of moderate thickness, resumes the advantages which, under a somewhat inconsiderable impulse of popular opinion, were too little appreciated.'

The most competent authorities abroad are unanimous in the opinion that the first-class ironclads of the British Navy are triumphs of naval architecture. Among the conspicuous merits of our latest ships, we may mention their proved capability of keeping the sea in any weather, their abundant coal-supply, and the powerful calibre of their artillery. It is not too much to say that, by the originality displayed in their design, and the skilful workmanship with which they have been constructed, the prestige of our country has been sustained, and, indeed, in a very high degree increased. If it were probable that the Navy would be required to operate chiefly in ocean warfare, it might be the wiser course to continue to build ships of the 'Inflexible' type, in preference to smaller vessels. But there is no immediate prospect of naval operations on the broad ocean. The principal maritime Powers are directing their attention chiefly to warfare of another kind—to the attack and defence of forts and harbours; and for coast operations ocean-going ironclads are not adapted. In the United States, no new ironclads have been commenced since the close of the civil war. In his report for 1875, the Secretary of the United States Navy says: 'Our circumstances do not require that we should take part in the rivalry between monster cannon and impenetrable armour, since few of our ports are accessible to vessels carrying either, and these may be better defended by attacking the

vessel below her armour by sub-aqueous cannon and moveable and stationary torpedoes.' In Russia attention has of late been directed chiefly to the circular ironclads, the 'Popoffkas,' which are intended solely for coast defence. In Germany it has been decided to lay down no more ironclads at present. In France the programme of shipbuilding was settled in 1872, when it was decided that sixteen first-class and twelve second-class ironclads should be built. Financial considerations have prevented the execution of these plans within the period of ten years originally contemplated, and, while the delay has caused deep regret to many members of the French Legislature, with others that regret has been tempered by the conviction that in a period of such rapid transition, it was impossible to spend large sums on shipbuilding, with any confidence that the ships, when built, would represent the latest ideas of naval constructors. *Sir T. Brassey.*

In his essay, *La Marine d'Aujourd'hui*, Admiral de la Gravière asks, but does not answer, the question, What kind of squadron will the admirals of 1882 be called upon to command? He appears so much in doubt as to future transformations of *matériel*, that his attention seems to be mainly directed to the effectual training of the *personnel* of the fleet.

On examining our shipbuilding programme of the present session, one salient feature will be at once noted. With a single exception, that of an armoured torpedo vessel, all the armoured vessels proposed are of large tonnage. The list includes the following ships:—

Agamemnon	each of 8,492 tons
New Agamemnon	
Ajax	
Dreadnought	10,886 tons
Inflexible	11,406 tons
Nelson	each of 7,323 tons
Northampton	
Shannon	5,103 tons
Téméraire	8,412 tons
Torpedo ram	——

It cannot be doubted that all the ships under construction will prove formidable additions to the Navy. It is not contended that the construction of first-class vessels of war should be discontinued; but it is a subject for regret that, whereas, according to the Navy Estimates of the present session, it is proposed to build only 8,000 tons of ironclad shipping, we have so largely and rapidly increased the dimensions of individual vessels, that the whole shipbuilding of the

Sir T. Brassey. year is only sufficient to produce a single ship, liable to instant destruction by weapons of a comparatively inexpensive nature, which can be multiplied therefore in almost overwhelming numbers. Moreover, while the dimensions have been carried to the furthest possible point, there yet remain some unquestionable defects. The armament of our most recent ironclads is unsatisfactory. Their guns, although of tremendous calibre, are too few in number. In the excitement of action we cannot rely on perfect accuracy of fire, even were the field of view unobstructed by the smoke which must inevitably envelope the contending fleets. Of the uncertainty of artillery practice, no more striking proof could be produced than that which was quoted by Captain Price, in the course of the discussion on Captain Scott's lecture, delivered at the Royal United Service Institution, on the maritime defence of England. Captain Price stated that the only practical test as yet applied to our large guns, in respect to accuracy of aim, was made in 1870, when our three largest ships, the 'Captain,' the 'Monarch,' and the 'Hercules,' were sent out from Vigo Bay to fire at a rock, distant about 1,000 yards. The day was almost absolutely calm. The rock was 600 feet long, and 60 feet high— that is to say, twice as long and four times as high as a ship. The 'Hercules,' armed with 18-ton guns, fired seventeen shots, of which ten hit. The 'Captain,' armed with 25-ton guns, fired eleven shots, and made four hits. The 'Monarch,' also armed with 25-ton guns, fired twelve shots and made nine hits. Captain Price, arguing from these data, agreed in the opinion, previously expressed by Captain Colomb, that the 'Monarch,' which, in six minutes from the time of opening fire, would have fired twelve shots, could only expect to hit a sister vessel at a distance of 1,000 yards from twice to fifteen times out of every 100 shots. He further remarked that 'as the size of our gun increases, so we must expect the accuracy of the gun to decrease.'

Captain Scott lays it down that the armament of a first-class fighting ship should not be less than one gun to every thousand tons displacement. The 'Inflexible' has only one heavy gun to every 2,000 tons displacement, and her armament, being mounted in pairs in two turrets, and loaded and trained by mechanism, a great portion of which is common to both guns, cannot be reckoned as having the same relative value as four independent guns. If a projectile were to penetrate a turret the pair of guns mounted therein would probably be disabled. Four guns, therefore, mounted in pairs, cannot be reckoned as equivalent to more than three guns mounted and worked independently. It is a weak point in the 'Inflexible' class that

they have no light armament with which to defend themselves against gunboats and torpedo vessels. *Sir T. Brassey.*

Again, the armour in the latest designs covers only a limited area of the sides of the ship; and the unprotected ends, even though filled with cork and coals, and subdivided into numerous cellular compartments, are alleged by Mr. Reed to be fraught with considerable danger to the armoured citadel. I am not competent to arbitrate in the controversy between Mr. Reed and Mr. Barnaby; but I venture to point to the present discussion as an argument of incontrovertible weight against the policy of building vessels of extreme dimensions and consequently excessive cost. If a new argument were needed, in order to show the desirability of distributing more widely the risks of naval war, and increasing the means of attack—objects which can be best attained by multiplying the number of our fighting ships—it would surely be found in the deplorable controversy which has arisen respecting the 'Inflexible.' Having enlarged the dimensions of a single ship to 11,400 tons, and having expended upon its construction a sum which may be estimated at not less than half a million sterling, we have the mortification of hearing from a high authority that our enormous and costly ship is not fit to go into action.

There is reason to believe that other features in the most recent designs are not altogether satisfactory. The magazines are outside the citadel, with only a 3-inch armoured deck over them. The weakness of the bow for ramming is a still more serious consideration. 'Suppose,' as it has been suggested by a distinguished flag-officer, 'a ship with unarmoured ends should be obliged to meet another, bow to bow, at full speed (a most likely occurrence); nothing could save her from immediate destruction, provided that her opponent were armoured, and therefore the stronger. If the "Devastation" or the "Dreadnought," which are armoured round the bows, were to steer straight for the "Inflexible," they would inevitably have the advantage over her weakly-constructed bow. If the "Inflexible" were to endeavour to avoid the blow, she must expose her side to the enemy, which would be still more dangerous.'

It is disappointing to be informed of the existence of so many defects in our most ingenious and costly ships; and the British public will probably be disposed to concur in the opinion expressed by Mr. King, of the United States Navy, in his description of the 'Inflexible,' quoted in the *Engineer* of June 22: 'Almost every conceivable precaution,' he says, 'has been taken to make her secure from the ram and the torpedo. If, however, she should be fairly

Sir T. Brassey. struck by a solitary powerful fish-torpedo, it is quite possible that she would be crippled, water-logged, or possibly sunk.' The question, therefore, presented to us is whether two vessels of smaller dimensions, each carrying two 81-ton guns, instead of four, would not have been a safer, and, in some respects, a better investment.

It was stated at the outset that it was not proposed to criticise the designs of our most recent ships of war, or to advocate any original views on naval architecture; but rather to ascertain the opinions of the most competent professional authorities, and to see how far the latest programme of shipbuilding was wisely framed for the purpose of carrying out their recommendations. The controversy as to the continued use of side armour must naturally arouse the greatest anxiety in the country. It is said, that unless armour be strong enough to keep out shells, it is worse than useless; and armour, more or less impenetrable, even when limited to vital places, such as the water-line, the engine-room, and the boiler-space, involves a large addition to the cost, and an increase of dimensions, tending to diminish that mobility which is of the last importance.

In considering this subject, it is essential to bear in mind that the increase in the tonnage of our most recent ships has been rendered necessary by the weight of their armour; that armour is a protection against artillery fire alone; and, that while the power of the guns may be indefinitely augmented, there is an inevitable limit to the thickness of armour. The argument against armour was very ably summed up by Sir William Armstrong, in his letter to Lord Dufferin, Chairman of the last Committee on Naval Designs:—

'The foregoing considerations as to the present effects and probable future of guns, projectiles, and torpedoes, lead me to the conclusion that no practicable thickness of armour can be expected to secure invulnerability for any considerable length of time. At present it is *only the most recent of our armour-clads that have any pretence to be considered invulnerable.* All the earlier vessels, when built, had just as much claim to be so regarded as the strongest ships of the present day; yet they are now completely left behind, and are, in my opinion, much inferior to well-constructed unarmoured ships. I venture to ask, what reason have we to suppose that the powers of attack will not continue quickly to overtake the increased powers of resistance, which we are applying at great increase of cost, and at great sacrifice of general efficiency? Every addition to the weight carried for defence must be attended with a diminution of armament and of speed, unless the size of the ship be increased in a very rapid

proportion. A continual addition, therefore, to the thickness of the armour involves either a continual reduction of offensive power, or such an increase in the size of the vessel and its consequent cost as must limit the production of sea-going ships of war to a number inadequate for constituting an efficient Navy.' *Sir T. Brassey.*

It may be thought that Sir William Armstrong, as an artillerist, would naturally be impressed with the irresistible power of guns against armour; but when we turn to the official declarations of the constructors themselves, we find them substantially in accord with the view expressed in the foregoing extract. The papers relating to the design of the 'Inflexible,' recently presented to Parliament, contain a well-balanced summary of the arguments for and against the continued use of armour:—

'We do not see that any increase in the penetrating power of guns can make it desirable to dispense with hull armour, merely because it is penetrable to some guns within certain ranges. It will always remain impenetrable to all guns beyond certain ranges, and to many guns at all ranges, and must therefore be advantageous as a means of security to the vital parts of the ship.

'The limit to its thickness is to be found, we think, in the size and cost of the ship.

'So far as we have gone at present, fourteen inches of armour have been found to be consistent with high speed, perfect turning power, and moderate draught of water. No one of these conditions imposes a limit: but a single ship costs nearly half a million sterling and it is exposed to many risks.

'The losses and casualties of a naval engagement would do much, there is no doubt, to bring out the imminence of these risks, would perhaps show that the large and costly ship is even more exposed to them than the smaller one.

'It may be that the limit of size and cost has been reached in the "Fury," and that, with her bulk and cost, the maximum of advantages may be obtained.

'We are ourselves disposed to think that this is so, and that there may be retrogression in this respect, as more experience is gained with the powers of the torpedo, the ram, and other submarine instruments of attack.'

Let us now refer to another official statement, emanating from the Council of Construction at Whitehall. On the 6th of April, 1876, Mr. Barnaby read a paper at the Institute of Naval Architects, in which the relative merits of very large ships, as compared with vessels of more moderate dimensions, were ably discussed.

Sir T. Brassey.

'The attack,' he said, 'of several fast unarmoured rams and torpedo-boats upon a somewhat slower armoured ship, although involving the probable destruction of some of the attacking vessels, would still expose the armoured ship to a risk which she ought never to encounter alone. The assailants ought to be brought to bay, before they could get within striking distance of the ironclad, by consorts, armed, like the attacking vessels, with the ram and the torpedo, which may take, like them, the chances of being sunk. In other words, I contend that the defence against the ram and the torpedo must be sought for, not in the construction of the ship alone or mainly, but also and chiefly in the proper grouping of the forces at the points of attack. Each costly ironclad ought to be a division defended against the torpedo and the ram by smaller numerous but less important parts of the general forces. If the foregoing considerations are correct, there is still place in naval warfare for costly ironclads with thick armour and powerful guns. There is place also for association with them of unarmoured vessels armed with the torpedo and manned by brave men.'

The ex-Controller of the Navy, Sir Spencer Robinson, was present among Mr. Barnaby's audience. In the course of the discussion on the paper just quoted, he gave his full approval to the proposal to provide a supplementary flotilla as necessary auxiliaries to a fleet of ironclads. 'No suggestion,' he said, 'more valuable for the purposes of war has been made by any person within my knowledge than the able suggestion of Mr. Barnaby, that the true mode of defending our heavy ironclads from these attacks is by the counter attack of torpedoes and rams. No fleet, therefore, can be considered a fleet, and, in my humble opinion, no ship like the "Inflexible" can be considered a ship of war, unless provided with attendant rams and torpedoes to meet those attacks to which she is sure to be subjected. I am quite satisfied also that Mr. Barnaby has hit upon the right plan of defending such ships from the attacks of torpedoes. It is by counter-attack that you must succeed, and not by piling mountains of iron upon the sides of your ships.'

Though not a naval architect, Sir Samuel Baker has won a high reputation among his countrymen for distinguished success in another field of effort. Having directed his attention as an outsider to the subject of the present paper, he arrived at a conclusion almost identical with that expressed by Mr. Barnaby. Sir Samuel Baker's views were set forth in a letter to Mr. E. J. Reed, and were rightly deemed so sound a contribution to the discussion, that they were published as a note to Mr. Reed's speech, in the Transactions of

the Institute of Naval Architects. They were to the following effect:— Sir T. Brassey.

'Accepting, as a matter of course, that the comparatively short handy ironclad must be the fighting giant of the present and future, instead of the long ships of the "Minotaur" class, it appears to me that *every* ironclad should possess two tenders that would *absolutely be inseparable attendants.* These tenders should be wooden vessels, with an *immense* speed, fitted as rams—tonnage about 2,500.

'Each accepted ironclad of the Navy would thus be accompanied by two fast handy rams, which would never leave her, but would belong to her as entirely as the horses do to the field-gun.

'These rams would, in action, wait upon the ironclads. Each ram-tender would be provided with two torpedo steam-launches—thus in smooth weather a single ironclad (carrying herself two torpedo launches) would exhibit force as follows:—

1 Ironclad,
2 Rams,
6 Torpedo launches.'

The advice of officers who have been engaged on active service will naturally be received with special deference. At the close of the civil war, the Secretary of the United States Navy invited each of the flag-officers of the fleet to prepare a report on the types of ships which they considered it desirable to introduce into the American service. Several very interesting and valuable statements were submitted, among which I would more particularly refer to a paper by Admiral Goldsborough, which shows a degree of wisdom and forethought far in advance of the time when it was produced. Writing in 1861 he says:—

'A marked pause must occur in the progress of ordnance before a fixed or definite conclusion can be reached as to the relative immunity obtainable by iron plates. Absolute immunity is out of the question.

'That progress has already produced the effect of restricting their application, in the case of sea-going vessels, to the more vitally exposed parts; and it is quite possible that it may finally establish the conviction that such plating for such vessels is really of no marked consequence.

'In the meantime the tendency of its effects must be to impress the value of rams.

'The protection of harbours nowadays does not lie in forts; it

Sir T. Brassey. lies essentially in powerful steam-rams, aided, when necessary, by obstructions in passage-ways.

'Rams, intended purely for harbour defence, would be better without than with guns. They themselves are to be the projectiles, and the steam the powder.

'To fit the rams for guns would be to swell the item of cost largely, and thus abridge their multiplication.

'The essential points to be secured in these rams, each to a degree as consistently with all the rest as practicable, are great strength throughout every part of the hull, not overlooking the bottom by any manner of means; every protection that supportable plating can afford, a high velocity, an ample security of machinery, the utmost rapidity in turning, and a suitable bow.'

The next great action, after the close of the civil war in America, was fought at Lissa. What did the officers in command give as the result of their tragical experiences on that occasion? Their views were quoted by Captain Scott in his lecture (to which reference has already been made) delivered in 1876 at the Royal United Service Institution. 'The ram,' he said, 'has been aptly termed the "naval bayonet," and is a weapon which, if handled with skill and pluck, will prove invincible. Its special fitness for British sailors was referred to in my last lecture, and the Chief of the Naval Constructive Department of the nation which used it with such effect off Lissa says of this weapon—when speaking of the reconstruction of three vessels of the Austrian Navy at the cost of one ironclad—"That we, as the result of this cheap conversion, now possess three rams, the most dangerous and secure weapons, I consider, and compared with which, the action and effect of the aggressive torpedo is, in my opinion, doubtful and insecure, and may easily endanger the ships of its own fleet."'

Admiral Persano's memorandum on the battle of Lissa, also quoted by Captain Scott, would seem to imply that the experiences of the engagement had made the same impression on the vanquished as upon the victors. 'As encounters between ironclads will,' he said, 'be decided rather by the ram than by the fire of artillery, that fleet would undoubtedly win the battle which had the greatest number of ships fitted with double screws.'

Turning to the French Navy, we find that Admiral Jurien de la Gravière predicts that 'ships will fight in the future with the rams alone. The captains will not dare to open fire, lest their view of the enemy should be obscured by the smoke from their own guns. When the two fleets have passed through one another, they will turn and

renew the attack. In the execution of this manœuvre the slowest ships will expose their broadsides to the enemy, and will inevitably be destroyed by the ram.' Armour is valuable only as a protection against the fire of artillery; and the ram and the torpedo are now regarded by the highest naval authorities abroad as their most formidable weapons. *Sir T. Brassey.*

M. Dislère, in his latest publication, expresses an opinion that the difficulties in the use of the torpedo in action are not as yet surmounted. 'But this fact,' he says, 'only lends the greater importance to the ram, and renders it the more necessary to reduce as much as possible the dimensions and the displacements of our fighting ships.

While the efficiency of the ram was signally manifested in the action off Lissa, the destructive powers of the torpedo have been exhibited on a very recent occasion in the terrible destruction of a Turkish monitor on the Danube. In the United States great attention has been given to torpedo warfare. All the ships of the American Navy are provided with the spar torpedo, and efforts are continually being directed to the production of an efficient automatic subaqueous torpedo. The chances of attack by means of unarmoured steam launches have also been considered; and on this subject the views of the majority of naval officers are contained in an article in the *United States Army and Navy Journal* of June 2, 1877, from which the following is an extract:—

'The steam-launch is by no means so terrible an invention as is supposed. A single discharge of grape from a ship, attacked by the "Thorneycroft" launch, will destroy and almost instantly sink this supposed irresistible ironclad destroyer.

'Vessels intended to carry torpedoes to be exploded against ships armed with guns are practically worthless, unless capable of resisting shot.

'But, against an assailant possessing a torpedo-boat with a flush impregnable deck and movable submerged torpedo, as described in our last issue, neither grape nor rifle shot will avail; the vessel attacked, whether a little monitor or a first-class ironclad ship, will certainly be destroyed, unless the position and other circumstances admit of rapid retreat.'

In the Navy Estimates for the year 1877, provision is made for commencing the construction of a vessel of the type recommended in the American journal. It cannot be doubted that such vessels would prove extremely formidable in action.

The recent encounter between H.M.S. 'Shah' and 'Amethyst'

Sir T. Brassey.

and the Peruvian ironclad ship 'Huascar' is full of interest, in relation to the question of retaining armour for the protection of ships of war. The results of the combat are obviously in favour of the retention of armour. Though the 'Huascar' was struck 100 times only one 9-inch shot penetrated three inches into the turret, and that without doing any material damage. The engagement was fought at distances varying from 200 to 3,000 yards, and lasted three hours. As the plates of the 'Huascar' were only 4½ inches in thickness, the armour would easily have been penetrated by the 'Shah's' 9-inch and 7-inch guns, provided that the shot had struck at right angles. The experiences of the action show how rarely this is likely to occur in practice, and how immensely the power of destruction is reduced when the armour is struck obliquely.

The lessons to be learnt from the engagement between the 'Shah' and 'Huascar' will doubtless be appreciated by the constructors at Whitehall. They will probably adopt in the future the system of inclined armour, so ably advocated by the editors of the *Engineer*. In an article which appeared in that paper on April 14, 1876, it was shown that, if the armour were inclined upwards at an angle of 45 degrees, a thickness of 12 inches would be sufficient to resist even the 81-ton gun, whereas, with armour on the vertical system, twice the thickness would be required. It was further shown that by the reduction in the breadth of the armoured deck over the central citadel, the top-weight would be considerably reduced, and that the armour protection on the sides of the ship might be proportionately extended. By the adoption of inclined armour a larger reserve of stability may be secured, and so the objections which have been raised by Mr. Reed to the 'Inflexible' may be removed in future designs.

In conclusion, a few suggestions may be offered as to the shipbuilding policy most suitable for a period of rapid transition in the modes of naval war and naval architecture. It is not necessary to spend a larger sum than at present, nor is it proposed that the construction of ships of the best type for ocean warfare should be discontinued. It must be admitted by every English statesman that, so long as we retain our colonial empire, we must maintain a fleet, on which we can rely to guard our communications across the seas. It does not follow that any ships destined for this service need exceed a displacement of 8,000 tons, which is less by one-third than the tonnage of the 'Inflexible.' With a view to a reduction of dimensions, it would probably be the wiser course to aim at making our ships unsinkable rather than impenetrable, to increase the

strength of the structure below the water, and to diminish the armoured protection of the guns. If the guns should be disabled, the ram could still be relied upon, provided the vitals of the ship remained intact. *Sir T. Brassey.*

The most recent experiences with the ram and the torpedo point distinctly to the importance of numbers, to the unwisdom of placing too many eggs in one basket, and to the expediency of distributing the inevitable risks of naval warfare, by sending forth fleets, not only strong in the power of the individual ships of which they are composed, but strong in regard to numbers. To this view Mr. Reed himself has given his sanction in a recent debate in Parliament, when he said that the increased efficiency of the torpedo made smaller vessels desirable. It is most unwise to spend all the money devoted to the construction of vessels for the line of battle in building ships of the 'Inflexible' or 'Agamemnon' type. Let us appropriate one-third or one-half from the vote for armoured ships to vessels, let us say, not exceeding from 2,000 to 3,000 tons. With these restricted dimensions we cannot have all the qualities which it has been attempted to combine in the 'Inflexible,' but we can have vessels formidable either with the gun, the ram, or the torpedo; and, in proportion as we add to the number of our ships by reducing the dimensions of individual vessels, so the loss to a fleet of any single ship, disabled or destroyed in action, will be less disastrous.

The administration of the Navy must never be degraded into a party or personal question. We are all united in one common object —that of creating and maintaining a powerful Navy. The supplies necessary for such a purpose will always be cheerfully granted. The question we have to consider is whether the money voted for the Navy is effectively applied to the great national object in view.

The development of the means of defence has not been even with the increasing power of offensive naval weapons. Should it not therefore be the policy of our naval administration to expend a larger proportion of the ample resources at their disposal in so multiplying their means of attack, that no hostile fleet will venture to expose itself to inevitable destruction by engaging a British squadron?

At the present moment the controversy as to the stability of the 'Inflexible' has aroused a painful feeling of anxiety. The Government have been well advised in appointing a committee of inquiry, composed of men eminent for their scientific attainments, and holding independent professional positions. Neither Parliament nor the country would have been satisfied with an expression of confidence, emanating from Whitehall, and unsupported by other

Sir T. Brassey. professional testimony. The controversy which has been raised is unprecedented in its character. A difference of opinion has been expressed between two authorities of exactly equal rank. The one has been, the other is, the Chief Constructor of the Navy. They differ on a question of fact, which can only be exhaustively investigated and decided by men of competent scientific attainments. It was merely throwing dust in the eyes of members of Parliament unskilled in the science of naval architecture to invite them to inspect a model, which might or might not be an exact model, and to observe the behaviour of that model in a trough under conditions which might or might not represent the conditions to which the ship would be exposed in action, or in navigating the seas.

An objection may be entertained in some quarters to the appointment of a committee or a commission, to consider the designs of our ships of war. It may be thought that the Admiralty are thereby relieved of that responsibility which ought not to be shared with any other co-ordinate authority. It must, however, be acknowledged that at the present time the ship-building problem presents difficulties quite unparalleled in the previous history of the Navy. I gladly acknowledge that the present Naval Lords, if they were not in office, would constitute a most able commission. But my fear is that, at the present moment, they have no leisure to investigate new problems of armament, tactics, and construction. Mr. Samuda, in seconding a motion introduced in the House of Commons by Mr. Seely in 1868 said—as I think, truly—that when a great policy had been inaugurated, he could well understand that a department of the State might efficiently carry it out; but it was unlikely that such a policy could be initiated by a Government department. The State, by appointing a commission of inquiry, would obtain the assistance of men of the greatest ability, experience, and knowledge in the kingdom, who would freely give evidence. Similar views were expressed, though with becoming official reserve, in the same debate by Mr. Childers. He wished for some plan which, without diminishing the responsibility of the constructive department of the Admiralty, would give it the advantage of a certain amount of scientific investigation and advice.

Investigations such as that proposed in the case of the 'Inflexible' can scarcely fail to do good. The public is supplied with the latest information on the condition of the *matériel* of the Navy, and the Admiralty may receive novel and valuable hints for the improvement of the fleet.

The first intelligence of the engagement between the 'Shah,'

Sir T. Brassey.

the 'Amethyst,' and the 'Huascar,' had not reached this country when the foregoing pages were written. Even now official information is wanting. What we already know, however, is sufficient to prove that evolutionary qualities are of the highest importance, that deep draught is a serious disadvantage, and that a mixed armament, including an adequate proportion of armour-piercing guns, is necessary to constitute an efficient vessel of war. It has been said that an encounter between an unarmoured and an armoured vessel is so unequal that an officer in command of an unarmoured ship would always be justified in declining an engagement; but, while the British Navy continues to be animated by its ancient spirit, a commander will never decline an action so long as his vessel remains afloat. When we take into view the expenditure on the unarmoured 'Shah,' and the circumstance that she was manned by a crew of 600 men, it is unsatisfactory in the highest degree to know how unequal was the battle between the British flagship and the Peruvian ironclad. If we give up armour, let us at least secure a compensation in superiority of numbers. It may not be worth while for the protection of commerce to construct ships so costly as the smallest armoured cruiser must needs be; but, if we do abandon armour, let us be content with a vessel of moderate tonnage, of the 'Alabama' type. By so doing, we shall construct three or four unarmoured vessels for the price of one 'Shah,' and, by combining squadrons of small vessels in battle against one larger antagonist, we can compensate for inferiority of armour and guns by superiority in that formidable weapon, the ram. If, instead of one 'Shah,' Admiral de Horsey had had three or four rams under his command, he would probably have sunk or captured the 'Huascar.'

TACTICAL ADVANTAGE OF SUPERIORITY OF NUMBERS.

Mr. Laughton.

Mr. Laughton. — *The Scientific Study of Naval History.* Royal United Service Institution, June 22, 1874.

We find that whilst each battle has its own distinctive characteristics, rendering the details of each very different, they all depend on the same principle, however varied the application of it—the principle of concentration of force. New names have been sought for this: it has been called, for instance, 'breaking the line;' as if breaking the line was the main thing aimed at—was anything more than an accidental accessory; as if there was some charm about 'breaking the line,' which at once insured victory; or as if the attacking line was not necessarily as much broken as the line attacked. The great masters of the art—Howe, Jervis, Nelson—knew better; and though they broke the enemy's line when it seemed advisable to do so, there can be no doubt that they considered it merely as a means to an end. That end was to overwhelm *part* of the enemy's fleet by throwing a preponderance of force against it.

It is not my province here to enter into a detailed criticism of the tactics of battles, but to show how history properly studied teaches the principles on which battles have been won, or not won—have been lost or not lost—and the lesson so given is this: that in modern times, against a disciplined enemy not subject to bewildering panic, an attack cannot be decisively successful unless it is made by a great superiority of force; not necessarily a superiority in the aggregate, but at the point of attack. This lesson is not peculiar to our own service; it is not our own private property; it was learned by the soldiers thousands of years ago, and, so far as I can make out, a few years before the sailors had an opportunity of practising it; for, it seems to me, after a careful study of the narratives that have come down to us—a study carried on, I may say, on the spots hallowed to their glorious memories—that Miltiades at Marathon, and Themistocles at Salamis, crushed their outnumbering foe by the early development of the same principle which, in these later ages, proved so fatal to the enemies of Napoleon or Nelson.

It may perhaps be thought that in insisting on the historical truth of this principle I am insisting on a truism—that I am trying to prove that *two* is greater than *one*, instead of leaving it to your common sense to see that it is. But I have heard officers maintain that a naval battle in the future must resolve itself into a series of single actions between the ships composing the hostile fleets; and this has lately come before me as the opinion of an officer whose name deservedly stands high in the service. I think myself that such an opinion is unscientific and untenable. *Mr. Laughton.*

In course of the discussion which followed, Vice-Admiral Sir Cooper Key said:—

'No doubt great changes have taken place, but the principles on which our naval tactics must be based remain as they were; we have the same desire to concentrate our force on a portion of the enemy.' *Sir Cooper Key.*

A paper on a 'New System of Naval Tactics' was read by Lieutenant Graham Bower before the Royal United Service Institution, May 31, 1875. In the discussion which followed the following opinions were put forward:—There is no tactical skill in meeting an equal force with an equal force; it has been proved over and over again in all history, that meeting ship by ship cannot lead to any decisive result, unless there is great individual difference; that if the forces are really equal, nothing but manœuvring in some way, so as to bring two or three or more ships to bear on one, or a large part on a small part, can possibly be successful. Let the enemy take what form he will, I conceive there is no tactical advantage in attacking him in any way that will not bring the bulk of the attacking force to bear on a small part of the attacked. *Mr. Laughton.* **Remarks in discussion on Lieutenant Bower's paper, 'New System of Naval Tactics,' Royal United Service Institution, May 31, 1875.**

Lieutenant Charles Campbell, R.N.

'QUE LA GUERRE N'EST AUTRE CHOSE QUE L'ART DE RÉUNIR PLUS DE MONDE QUE L'ENNEMI SUR UN POINT DONNÉ.'—*Napoléon.*

I chose the above as the motto for this essay on account of the truth which I believe every word of it contains. That the assembling of a larger force than the enemy, on any given point, is the one object to be attained, the one end and aim of all strategical combinations, I feel perfectly convinced. Nelson, our great naval leader, won his victories on this principle; and Napoleon enunciates it as the first tenet of his creed. *Lieutenant C. Campbell, R.N.* **Essay on Steam Tactics. Papers of Junior Naval Professional Association, Griffin, 1874.**

Baron Grivel.

Admiral Baron Grivel.

De la Guerre Maritime, chap. vii. p. 147.

Car ici, ne l'oublions pas, le *nombre* est un élément capital de succès!—S'il est une arme de nature à égaliser les chances entre le faible et le fort, c'est assurément l'éperon!—Un bélier à bon marché, c'est-à-dire une masse de 1,000 à 1,500 tonneaux de déplacement, abordant sur la normale, avec une vitesse de 7 à 8 nœuds, suffirait, selon toute apparence, à couler le plus grand navire cuirassé.

L'amiral Dahlgren demande avec raison que ces béliers agissent toujours,—'*par groupes de deux ou de trois*'—afin qu'il soit impossible aux navires poursuivis de se dérober, par un simple coup de barre, à leur choc redoutable. Cette dernière considération nous paraît bonne à retenir et fondée sur les lois les plus évidentes des évolutions navales.

AUTHORITIES IN FAVOUR OF LARGE DIMENSIONS FOR FIRST-CLASS SHIPS.

ENGLISH AUTHORITIES.

Sir Spencer Robinson.

Sir Spencer Robinson.

Observations on reports of experimental cruise of the Channel Fleet, 1866.

The last remark I shall make upon the various qualities of the ships under sail is that in this case, as when ships are under steam, large vessels have a great advantage in steadiness over small, the largest ship of the fleet, the 'Achilles,' being the steadiest, and propelled by the smallest amount of canvas in proportion to her size.

I may add that the propelling power, whether of steam or canvas, is always less in proportion to displacement in large ships than in small; for instance, the 'Duncan' has 5·27 square feet of sail to every ton of displacement; the 'Galatea' and 'Ariadne,' 5·9; the 'Pearl,' 7·1; the 'Rinaldo,' 9·7; and the 'Plover' class, 9·9; yet it is almost certain that the 'Duncan,' the 'Ariadne,' or 'Galatea,' and the 'Inconstant,' would outsail the 'Pearl,' and the 'Rinaldo' and 'Plover.'

The 'Engineer.'

Engineer, April 28, 1876.

We have thus lightly sketched the principal features of the most important addition yet made by a single launch to the naval strength of Great Britain. Yet, while the ship is still incomplete, we are perplexed with doubts and fears as to the part she could play in a future war. If the 'Inflexible' were fairly struck by a powerful torpedo, there is good reason to think that she would be disabled, and possibly sunk. Her watertight compartments might, indeed, enable her to keep afloat for some time, but she would be waterlogged and crippled.

There are but two considerations which can be placed against this danger. The first is that the ship might be able to keep out of the range of any torpedo; the second is that unless the torpedo were

[illegible]

[illegible] a species of [illegible] which would surround the vessel on all sides, and prevent the approach of a torpedo by a distance of not less than six feet.

'Engineering.'

Engineering, March [illegible]

The second debate upon the Navy Estimates threw a little more light, but not much, upon the shipbuilding programme of the Admiralty. The new 'torpedo ram' is to be a small vessel, of 'about 2,000 tons,' and, therefore, only an auxiliary to the fleet. No new vessel of the first class is to be begun, and it appears our misgivings, expressed when the Estimates were first presented, that

the Admiralty are about to let other Powers obtain a distinct lead of us in shipbuilding, are justified by Mr. Hunt's avowal and even defence of the fact. *Engineering.*

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Mr. Reed, in accordance with opinions to which he has given increasing expression of late, stated in the late debate that he believed 'the proper answer to the large ships would be found in much smaller ships. It was quite possible to have a much smaller type of ship than the "Inflexible," which would have very powerful armour, be of great speed, and be very formidable indeed.' We do not think such vessels, however powerful each might be in proportion to its cost, would be the proper answer to the large ships. The proper answer, in our opinion, is suggested by other words spoken by Mr. Reed, which we deem exceedingly noteworthy. 'Our policy ought to be framed so as to have reference to the two facts that some States were going on increasing the power of the ship, and that there were apparently insignificant means which might be effectual for the ship's destruction.' This states the question, though not the answer, with both conciseness and completeness.

Other countries are building bigger ships, and big ships can beat little ones; that is admitted. But there are, *apparently*, insignificant means which *might* be effectual to destroy the big ships.

. . . .

Let every ironclad carry two torpedo launches, and if she cannot, let her design be altered till she can; let her bristle with Whitehead torpedo tubes, and be replete with every contrivance of the kind. Her cost will not be greatly increased by all this. Let every contrivance for exterminating big ships cheaply be put in force; but let us remember, in this balancing of probabilities, that many torpedo-boats will go to the bottom, *probably*, for one ironclad, and let us enforce the word 'cheaply.' All such means must be 'insignificant.' The 'torpedo ram' of 2,000 tons is not a cheap vessel, and of course does not fall under the description of an insignificant means of destroying large ironclads.

. . . .

If the answer to a new large ship is rightly another large ship, it must be because building large ships is the way to get the greatest fighting power out of a given sum of money. If so, why not always spend the money, when money is to be spent, in large ships, whether you are building 'in answer' to any particular large ship or not, seeing that the greatest fighting power at the least cost is the object of all ironclad ship-building? It may be replied that ironclads are

Engineering.

required for other services than heavy fighting; that small ironclads are more suitable for these than large ones; and that it is wise to build vessels adapted for both purposes even if subject to disadvantage in the line of battle. To this we answer, as we have often done before, that we disbelieve in using ironclads for anything but heavy fighting, but that, even if the argument be accepted unreserved, the country has already an ample supply of vessels suitable for these comparatively non-fighting services, and should now give all its strength to the completion of the fighting fleet.

. . . .

Others, again, take the more logical view that a large ironclad is better encountered—at equal cost—by spending the money upon several small ships than upon one large one, a view we have combatted frequently, on the simple ground that an 'Inflexible' costing half a million is more than a match in battle for the (very insignificant number of) small ironclads which can be built at the same cost. We will not repeat arguments used frequently in this journal, and will only say again that it was not a new 'Agamemnon,' or a new torpedo ram, that the Admiralty, in the present state of affairs, should have proposed to lay down, but a new 'Inflexible' with thicker armour and larger guns.

FRENCH AUTHORITIES.

Admiral Bourgois.

Admiral Bourgois.
From the Revue Maritime.

It is therefore a fair balance between the offensive and defensive qualities of ships, between the power of their artillery and their machinery, and the effective action of the helm, and the thickness of their armour, rather than the exaggeration of some of these advantages at the expense of others, that we ought to have in view in the creation of types of ships designed to contend for the supremacy of the seas. These qualities and these advantages, excepting always the power of turning in a short space, cannot but increase in proportion to the displacement. The result is that all maritime nations are led by their mutual rivalry to increase continually the dimensions of their newly-constructed ships.

When, however, we look to the economic aspect of the question, and to the possibility of securing the important advantage of a superiority of numbers, by devoting the same sum to the construc-

tion of smaller vessels, endowed with the faculty of turning in a shorter space, if not in a shorter time, we may be led to doubt the utility of this progressive increase in the dimensions of ships. *Admiral Bourgois.*

Let us suppose, for example, in order to fix our ideas, that we set side by side an ironclad of 10,000 tons and two others of 5,000 tons, naturally less swift, armed with a less powerful artillery, protected with thinner armour, but turning in a shorter circle. If the latter act in concert, as it has been stated in the course of this essay, the one meeting the enemy stem on, and the other attacking him on the broadside, it might happen that the large ironclad would suffer such serious injury, in the very first phases of the attack, as to be compelled to surrender, notwithstanding his superiority in every element of fighting strength save the evolutionary quality, over both of the smaller adversaries in single combat.

The smaller ships may also, by means of their light draught of water, possess the advantage of being able to navigate freely amid sandbanks and shoals, and may thus be employed with greater effect for coast defence. When employed in this special service, they may be enabled further, by reducing their supplies of all kinds, to increase either their speed or their offensive and defensive power.

Must we conclude from what has been said, that we should cease building larger ironclads, and confine our maritime preparations to ships like our armoured corvettes, and coast-defence vessels, according as they may be intended for service on foreign stations or for coast defence? This interrogatory may be answered distinctly in the negative, for, if such a policy were to be adopted, our adversaries would not fail to make use of the opportunity thus offered to them of sending to sea ships which, by a small additional displacement, might easily be made superior to our own.

The tendency to increase dimensions has existed at all times and among all the maritime Powers. Such a policy might be condemned, if we could consider the solution of the shipbuilding problem without reference to the decisions taken in other countries, or if in the day of battle we could bring together all the ships built with the same sum of money, for the two contending navies respectively. Every programme of construction, however, to be of any practical value, must be formed with due regard to the probable adversary, and to the means of securing to the type in construction an equality if not a superiority of strength as compared with that of the enemy; and among these means, for want of better, the increase of displacement presents itself so naturally, that it is highly probable that it will often be adopted.

Admiral Bourgois.

Our ships of 5,000 tons would engage ships of 5,500 tons, more powerfully armed, or better protected, or more rapid; and, as encounters between single ships are not uncommon in war, we might be exposed to the risk of seeing our flag compromised, as the flag of England was in the war of 1812 when carried by small frigates, which were compelled to enter into unequal combats with large American frigates.

It is further to be remarked that this superiority of two rams over a single ship of large displacement, armed with a powerful artillery, can only assert itself under special circumstances, and that it demands exceptional skill in handling his vessel on the part of the captain who seeks to deal a mortal blow at the side of the enemy. If the state of the sea or any other circumstance renders it impracticable to manœuvre for the purpose of ramming, the two ships will be compelled to sustain the combat with their guns upon unequal terms with an adversary superior to them in speed, in armament, and in the thickness of his armour.

If there be some deficiency in skill, if the attack with the ram has failed, or has had no result, the issue of the combat may be decided by the destructive fire of the large ironclad, as soon as he can bring his broadside to bear on one or other of the hostile ships. It is probable that the two smaller vessels would succumb in succession.

These observations apply to naval warfare with existing weapons. We are coming probably to the period when the sea torpedo will offer terrible obstacles to the ram, and superiority of numbers, as in the days when naval battles were decided by gunnery, will again determine the issue of an engagement.

Admiral Pothuau.

Admiral Pothuau.

Debate on the Naval Estimates for 1878–9. Chamber of Deputies.

We have a programme for the fleet fixed in 1872, and suited to our requirements, by which the Estimates for the supply of materials to the Navy are determined. Followed up with vigour, as we are firmly determined that it shall be, it will be realised at the latest in 1885.

It is with reference to this programme that the question is often raised as to the best system of construction for the purposes of war. Do we require large rams? Must they be protected with armour? Ought we, for the question is pressed even to this extent, to abandon armour-protection altogether? Finally: Is it necessary to carry the construction of artillery beyond the calibres actually in existence, and following the example of England to manufacture guns of 100 tons?

These are the questions to which it is very difficult to supply an answer. *Admiral Pothuau.*

Certain it is that, so long as neighbouring Powers pursue without intermission the policy now in vogue, it would be the height of imprudence for us to possess only ships of moderate tonnage without armour, and having only a weak armament.

All this is no doubt very costly; but how are we to do otherwise? When our neighbours arm themselves with the most powerful weapons, we have no alternative. We must follow their example.

AMERICAN AUTHORITIES.

Admiral Porter.

Report to the Secretary of the United States Navy, 1874.

The West India drill made it apparent that our combined force of vessels was incapable of a successful encounter with a fleet one-fourth as large, built on modern principles.

Indeed, one such ship as the British ironclad 'Inflexible' ought to go through a fleet like ours and put the vessels *hors de combat* in a short time, for she could either run them down or destroy them at long range with her heavy rifled guns.

We have no ordnance that would make any impression on such a ship at a distance of over six hundred yards, and no vessel of equal speed in our Navy would be placed under her fire by a prudent commander.

The report of the Committee on the design for the 'Inflexible' may be quoted in support of the opinion expressed by Admiral Porter:—

'In the event of her having to engage weak ironclads or unarmoured vessels, the "Inflexible" would have speedily planted amongst her opponents the few blows necessary to disable them.'

Secretary, United States Navy.

Secretary of United States Navy.

Annual report, 1868.

The 'Monitor' class have been proved well adapted for harbour defence. To maintain our rightful position on the ocean, vessels of greater size are essential. They must have all possible strength, endurance, and speed, and full sail power. A vessel of such a description must cost a large price. But a wise statesmanship will not fail to perceive that the possession of even a very few such unconquerable ships must, while vastly augmenting the force of the Navy, afford us an irresistible guarantee for peace.

ITALIAN AUTHORITIES.

Signor Brin.

Signor Brin.

Debates on Naval Estimates. Italian Chamber of Deputies, 1880.

In the debate in the Italian Parliament on the Naval Estimates for 1880, Signor Brin made the following observations, with reference to the designs for the new ironclads of the 'Duilio' and 'Italia' class. The question had been raised as to the expediency of constructing in place of the enormous ships, monsters as they have been called, vessels of a less expensive character, less powerful but less costly, ships which, in a word, were more consistent with the impoverished condition of the Italian Exchequer. He thought the weaker the Navy the more necessary it was that the *matériel* at its disposal should be perfect of its kind. If we were prepared to look to the example offered in recent times by America, we saw that that Power had always sought to create a perfect *matériel* for its Navy, and that, although infinitely less powerful than the English Navy, some successes had been won.

It was sufficient to refer to incidents which had occurred in the commencement of the present century, when a class of frigates was constructed of the same rate, but larger and more powerful, than the English frigates of corresponding rates.

The idea of constructing small ships as a match for large ironclads had many advocates. All those who interest themselves in naval affairs, will certainly have heard it maintained, that instead of constructing these large armoured ships, small ships should be built, swift and powerful, with all the qualities to be desired in a man-of-war, including that of moderate dimensions.

Evidently if it could be assumed that a ship could have every quality, including that of being smaller and less costly, there could be no question as to the advantage of small dimensions. But in order to arrive at any precise conclusion, and to make a fair comparison between merits of a somewhat conflicting character, we must know in some detail the type of ship proposed for our acceptance. We have vessels like the 'Duilio' and the 'Italia' actually in construction, and we know the various qualities they possess, their offensive and defensive power, and their speed; and we can determine their value with some degree of accuracy.

If we could compare with those ships which exist, vessels of the class which has been recommended, and could have the assistance of detailed plans, so as to be able to form a correct judgment on their respective qualities, it would then be possible to see which of the

two we should prefer; but, so long as we are asked to compare with existing ships a sort of myth (and, for his part, M. Brin did not know of any small ships which were both powerful and fast), it was impossible to come to a decision. We might always attribute to imaginary vessels every quality that could be desired, but their one fault was that they are not in existence. Signor Brin.

With reference to the general question of swift ships, M. Brin made the following observations.

To increase the speed of the 'Italia' by two or three knots only as compared with the 'Duilio,' the indicated power of the machinery had been raised from 7,500 to 18,000 horse. This example would give an idea of the heavy sacrifices required in order to attain high speeds.

In England it had been thought that great speed need not be insisted upon in first-class armoured ships. These vessels therefore do not steam more than 13 or 14 knots.

In this regard, opinion in England was divided. It had been argued by some whose judgment was of great weight, that these ships would always meet an enemy superior in strength; that it would never be necessary to retreat or to shrink from an engagement; and that the question of essential importance was the offensive and defensive power, in other words, the armament and the armour.

For a Navy like the Italian, necessarily of inferior power, it was urged by M. Brin that it was a wise policy to insist on the quality of speed. But in order to build ships which, in addition to their fighting qualities, were able to steam at a high speed, it was absolutely necessary to increase the power of their machinery and the supply of coal, in other words, to increase the displacements. Such was the explanation of the shipbuilding policy of the Italian N vy. The 'Italia' and 'Lepanto' carry the same armament as the 'Duilio,' but M. di San Bon, having desired that these ships should steam at a higher speed, had increased the power of their engines, and as a necessary consequence their tonnage displacement.

As between the two rival systems which have been described, the worst alternative, in the judgment of M. Brin, was that of making ships which had nothing to recommend them but speed and moderate displacements. In order to have small and swift ships something must be dispensed with, and as speed was insisted upon, it was inevitable that the fighting strength must be sacrificed. The final result would be, that the programme of construction for the Navy would consist of ships of great speed, but which, whenever they encountered an enemy, would be sure to find themselves

Signor Brin.

inferior in fighting power. To lay it down that the enemy must be always avoided, was a programme after a fashion; but it could be realised with greater economy by giving up altogether the construction of ships, capable of nothing more serious than to patrol the ocean, with the firm intention of avoiding a hostile encounter.

After all these discussions as to the policy to be adopted in the reconstruction of the fleet, everyone would ask whether, in view of the results attained in the trials of the 'Duilio,' that type was to be repeated without modifications?

If he recollected aright, M. di San Bon had expressed the opinion that every time that a ship was to be laid down, instead of copying types already in existence, an effort should be made not only to incorporate the improvements which had been finally sanctioned by naval science, but even to anticipate the future developments of naval architecture. M. di San Bon was of opinion that the 'Duilio' and the 'Dandolo' were constructed in conformity with these ideas, and did all he could to accelerate the construction of those vessels, increasing the armament from guns of 60 tons to guns of 100 tons weight.

The 'Duilio' was superior in armament to any ship afloat. In evolutionary qualities the diameter of the circle was at least as small as that of the other armoured ships in the Italian Navy. The speed exceeded 15 knots. There was only one ship in the English Navy, the 'Alexandra,' of equal speed, steaming at the measured mile 15·09 knots as against the 15·04 of the 'Duilio.' The difference was, in point of fact, inappreciable. There was, therefore, in the English Navy only one armoured ship, and that a ship distinctly inferior in fighting power, having less thickness of armour and less powerful artillery, which had steamed 15 knots. All the others were inferior in speed. The 'Devastation' steamed 13·8, the 'Dreadnought' 14·5, the 'Thunderer' 12·9, the 'Alexandra' 15·09 knots. Hence, with reference to speed, the 'Duilio' was a satisfactory ship. And now, in view of the results obtained, should the new ships be constructed of the same type? M. Brin would be the first to answer that question in the negative. The progress already achieved might suggest modifications of an even more radical character than those adopted in the 'Italia' and 'Lepanto.' It was difficult, therefore, to determine precisely what design it would be most advantageous to adopt for any ship to be commenced at the present time. The Italian Navy had entered upon a very difficult task, one which was not altogether free from dangers, but in which success could only be obtained at some risk.

Extracts from 'La Nostra Marina Militare,' by Benedetto Brin.

With the introduction of steam, navies entered into a period of incessant, and ever increasingly rapid, changes. Hence the direction to be taken in the construction of fleets has raised the most important questions: questions which have occupied, and still occupy, the thoughts of Governments and Parliaments. Difficult from their very nature, they became much more so, to a great portion of the members of political legislatures, through the technicalities of language by which they were successfully obscured. Hence is manifest a general tendency to leave the solution of these questions entirely to specialists. *Signor Brin.*

Amongst ourselves, the state of confidence was maintained through a long series of years. The two great armour-plated ships 'Duilio' and 'Dandolo' were laid down in 1872 by Admiral Riboty, the then Minister of Marine. Their type was adopted after a long study by the Superior Council of the Navy. 'Duilio' and 'Dandolo.'

In 1873 he was succeeded by Admiral San Bon, and Parliament was called upon to give its especial attention to the condition of our fleet. Opinions to these ships.

San Bon pointed out the ships which he considered bad, those he considered indifferent, and those which he thought good. In this last category, he placed without hesitation the two armour-plated ships 'Duilio' and 'Dandolo,' then in course of construction. *San Bon.*

In 1875 the shipbuilding question was discussed in the Chamber in an exhaustive debate. The following is an extract from the speech delivered by Admiral San Bon:—

'In a country like ours, it appears to me that there are various systems from which Parliament might make a selection. . . . Chamber of Deputies. Speech of San Bon.

'The fourth system, which I propose following, consists in this —that when about to lay down a ship you should examine in what direction the line of progress is tending; consider beforehand what ideas are likely to prevail at the time the vessel is launched, assuming as basis for this forecast the general tendency which ideas and facts have followed up to that time. Such a system seems to me the only one which is good, economical, and acceptable to a new country, to a country that has faith in itself. Acting in this way, when a vessel is at last launched, you have the certainty that she will remain effective for a fair length of time, because when she is launched she will be superior to those which are already afloat, and before most of the other vessels join her, she will have time

Signor Brin. to do her twenty years of service without falling too much to the rear. My predecessor, Admiral Riboty, understood this system, and showed that he understood it by laying down the two armour-plated ships "Dandolo" and "Duilio." A ship like the "Dandolo" or "Duilio" is worth in herself a fleet of the older ironclads which we possess. A struggle between the "Duilio" and the combined remainder of our fleet would be no doubtful struggle, if the vessels are considered simply as armoured vessels. The "Duilio" would have sufficient speed to keep at the requisite distance to avoid being hit. She would have most effective guns, and all the rest of the fleet would presumably give way before this one ship. She would place herself at a range where she would be absolutely invulnerable, and would send her projectiles one after the other with great accuracy—and this because when a man is in perfect security he aims well—and so the "Duilio" would rid herself of all the rest of our fleet. Hence she is an eminently economical vessel, however costly. . . . .'

Early tendency to increased dimensions. In every discussion, the first essential to admit of our arriving at truth, is an exactness of terms, a unity of measure, well defined and understood. In the fleet with which Queen Elizabeth opposed the Spanish armament, the English pointed to the 'Triumph,' a ship of 1,000 tons burden, as an immense ship; but a few years later, under James I., the 'Prince Royal' was a ship of the first class with 1,600 tons.

The 'Victory,' Nelson's flagship in 1805, a three-decker of 120 guns, was of 3,300 tons displacement; the 'Queen,' a vessel of the same class, but built in 1839, was of 5,000 tons; and the French 'Bretagne,' a first-class screw, built in 1856, was of 6,500 tons.

They were neither small, medium-sized, large, nor gigantic, but the best vessels which naval art could produce in each of those periods.

The large size of a ship cannot in itself be considered as an element of power; but as it may be taken for granted that no one ever built a big ship simply for the sake of having a big ship, but in order to admit of the introduction of something useful or necessary, with a view to obtaining a greater fighting power; so, taking into consideration that the size of ships has gone on increasing from hand to hand, the only logical conclusion is that our predecessors found themselves driven by sheer necessity to enlarging their ships.

American frigates in War of Independence. During the War of Independence the United States had not time to think about a Navy, but no sooner was peace established than they determined to build two frigates larger than the English frigates, and armed them with bigger and heavier guns. They were

named the 'Constitution' and 'United States,' and were launched in 1797. They carried 44 very heavy guns. The weight of iron fired by one broadside of the 'Constitution' was 768 lbs.; an English broadside, fired from the same number of guns, weighed only 517 lbs. *Signor Brin.*

In 1812 war broke out between Great Britain and the United States; and it became apparent that the American Navy had been well advised in adopting the principle of building ships which should be individually more powerful than the corresponding ships of the rival Power.

On August 19, 1812, the 'Constitution' met the English frigate 'Guerrière,' with the result, that after a fifteen minutes' fight, the latter had to strike, and surrender, to the superior fire of the American frigate. About the end of the month of October of the same year, the 'Macedonian,' an English frigate of 38 guns, met the American frigate 'United States,' was disabled by her, and surrendered. There was a third fight, this time between the 'Java' and the 'Constitution,' with the same result.

Taught by the results of the war of 1812–15, the Americans persevered more than ever in their naval policy, and introduced a new class of frigate, in which the fundamental idea, of securing a superiority over the corresponding types of other navies by means of increased size in hull and guns, predominated still more prominently. **'Minnesota' class.**

These new frigates were a kind of war-ship never seen afloat before, and in their sphere marked a revolutionary epoch in naval architecture. The 'Minnesota' may be taken as the type of this class of vessels, and the following were her dimensions:—

Length . . .	260 feet, or 94 feet longer than an English ship of 90 guns
Breadth . . .	51 ft. 4. in.
Tonnage . . .	3,307 tons burden, or 1,600 tons more than an English ship of 90 guns
Weight of broadside fire .	2,406 lbs., or three times the weight of the broadside of an English ship of 90 guns

These American frigates, which had almost twice the tonnage, and thrice the gun power, of a 90-gun ship, might, with much more reason, have been called 'gigantic ships' than the 'Duilio' and 'Italia,' which are hardly one-seventh larger than other armoured ships. The American historian, instead of taxing them with exaggeration, proceeds: 'These data clearly show the direction in which the

Signor Brin.

American Navy had embarked. The aim they had in view was to create a class of ships more formidable than any existing. The manner in which the great guns of the "Kearsage" struck and sank the "Alabama," clearly shows that ships like the "Minnesota" would have destroyed easily every wooden ship then afloat. In a war with Great Britain the triumphs of our first sea fights would have been renewed on a larger scale, and with more decided effect. No doubt the Navy of the United States, small as regards numbers, could not have coped with the immense fleets of England, but the "Minnesota," or any other ship of the same class and armament, would have captured any isolated English ship she might have come across.'

To whatever side, therefore, we turn, we find that whenever ships of greater power have been wanted, the way of getting such ships ha been by building them of a larger size; and it would be difficult to find exceptions to this principle, which therefore by its frequent repetition acquires the character of a general law. . . .

First-class battle ship.

The elements which serve as the basis for studying and ascertaining what a first-class line-of-battle ship ought to be, are few and simple. Admiral San Bon explained them with much clearness in the debate of 1875. . . .

These elements are three: great speed, to keep it in one's power either to attack with, or to run from, the insidious weapons of modern science; next, guns which shall not be inferior to those carried by foreign ships; and lastly, armour that shall not be pierced by foreign guns. The nation which on the breaking out of war possesses a *few* ships constructed on these principles, can be sure of beating any number of ships in which these qualities are wanting. It is useless to imagine that 'numbers' in themselves constitute a force that can be independent of the absolute force of each single unity of which the total is composed. . . .

Armour.

In America, when it gradually transpired that the Confederates were putting most powerful guns on their ships, experiments were made as to the thickness of armour required to protect the sides of a ship against such guns. It thus came to pass that by the end of that war, plates were being used of 30 c/m. (12 inches) and more; and throughout that war it was proved that the ship which relatively possessed invulnerable armour, invariably destroyed with her guns the more vulnerable ship she encountered; and in her turn was sure to be destroyed herself when meeting and fighting a ship whose guns were able to injure her armour. . . .

Hence, if the question as to what the dimensions of a ship ought

Signor Brin.

Monitors on the Mississippi.

to be is put in this way, namely, that given the necessary power of artillery and the required protection of armour, the problem will be best solved by the smallest ship, I say now, as I have said before, I entirely agree with this principle.

In this order of ideas, the monitors give a very good solution of the problem, as the surface they present out of water is small, and what they do present, the turrets, can easily be protected by powerful armour; but just because they possess such a low freeboard they are not sea-going ships.

In the 'Duilio' we have tried to solve the double question of fighting and sea-going qualities in one ship.

If you want monitors, you have only to repeat the 'Duilio' type on a smaller scale. . . .

I shall refer to another naval action during the American War, that which was fought on the Mississippi, at Vicksburg, on the 15th of July, 1862, and which the historian tells us, 'completely proved, as had already been done in the case of the "Merrimac," the immense superiority of armoured ships over every kind of wooden vessel, and over ships *insufficiently protected by armour*, as were our ships in the Mississippi.

'It was known that the Confederates were building an armoured ship on the Mississippi, the "Arkansas," a vessel they hoped would be able to destroy the Federal squadron that was in those seas. It was resolved to send another squadron to fight the ironclad; it consisted of the ironclad "Carondolet," armed with *smooth-bore* guns of nine and eight inches, and one rifled 100-lb. gun; of the gunboat "Tyler," and the ram "Queen of the West." No sooner had these vessels entered the waters of the Mississippi than they were attacked by the "Arkansas," which bore down upon them at great speed. The "Arkansas" carried eight-inch rifled guns.

'The Federal ironclad "Carondolet," and the "Tyler," opened fire, but without effect, whilst on the other hand, the Confederate shots riddled their sides and injured the crews. It was with difficulty that they fell back behind the rest of the squadron, and became unserviceable.

'The "Arkansas" continued her course, passed through the squadrons of Admirals Davis and Farragut, received point blank the fire of their nine and ten-inch guns, and returned it with her couple or so of guns. The result then was, that within a few minutes the "Arkansas" had entirely passed through the two squadrons, and had anchored under the guns of Vicksburg, without a single man

Signor Brin.

killed or wounded on board; whilst the Federal squadrons lost, the one fifty-seven and the other seventy-seven killed and wounded.

'Thus, a properly protected ironclad routed in a few minutes another insufficiently protected ironclad, and caused heavy losses in killed and wounded to two squadrons which together were not able to stop her course. The two Admirals were determined to make every exertion to destroy the "Arkansas," but without effect. The wooden ships fired on the forts, whilst the ironclad "Essex" and the ram "Queen of the West" proceeded to attack the "Arkansas."

'The "Essex" came down upon her at full speed, but the Confederate slipped her cable and cleared, so that the "Essex" ran into a bank; nevertheless she fired her guns at short range, without however injuring the Confederate. Meanwhile the "Queen of the West," in making an attempt to ram the "Arkansas," was so damaged by the latter's fire that she had the greatest difficulty in getting back to her anchorage.

'The "Essex" received three (direct) shots from the "Arkansas": one pierced her armour, and entered the battery, where it disabled four men; another pierced through her armour, and embedded itself in some timber, and so did a third shot. Admiral Farragut adds that another shot would have reduced the ship to a very bad condition.'

The writer is, therefore, right in asserting the immense inferiority of insufficiently protected ironclads to those which have the requisite armour.

To throw further light on this question, viz., as to the necessity of sufficient armour, I shall refer to the action at Mobile between Farragut and the Confederates. . . .

Operations at Mobile.

Admiral Farragut commanded the squadron which was to attack Mobile, which was strongly defended by forts, torpedoes, and a Confederate squadron under Admiral Buchanan.

He was pressed by the Government to begin, and he therefore made a personal reconnaissance of the defences, forts, and guns, the obstructions placed by the rebels across the canal between Fort Gaines and Fort Morgan, and the strength of the Confederate squadron. He became convinced that with one monitor he should be able to destroy the whole Confederate squadron, and then reduce the forts with the help of the troops. He informed the Ministry that the Confederates had a very powerful ironclad, the 'Tennessee,' besides a few gunboats partially armoured, and that, as it would be hopeless for him to attack Mobile without an ironclad ship, he requested that one might be sent. . . .

At last, towards the end of July, the Government was able to send him four monitors, and he fixed the 5th August for his grand attack on a fortress defended by a squadron. He had fourteen wooden steamers under his orders, and the four monitors, 'Tecumseh,' 'Manhattan,' 'Vinnetago,' and 'Chickasaw.' The wooden ships were bound together in couples, so that if one was disabled the other could serve as a tug. The monitors were to take up their position between the forts and the wooden vessels. . . . *Signor Brin.*

The Confederate Admiral waited the approach of Farragut's squadron that he might attack the ships, as he had done at New Orleans, after they had been riddled and thrown into disorder by the fire of the forts.

Having forced the passage, the Federal squadron either took, battered, or dispersed the Confederate gunboats. Fifteen minutes later, the 'Tennessee,' with Admiral Buchanan on board, moved from under the protection of the guns of Fort Morgan, and bore down straight on the Federal fleet, leaving behind the three smaller iron-clads, which were but poorly protected. 'The struggle which followed was one of the finest recorded, and at the same time showed the comparative value of the various weapons which were being used in the American War. . . .'

'By those who believe in numbers, Buchanan must be regarded as a madman; but let us put ourselves into his position, and consider the calculation he must have made. "It was true that the 'Merrimac' had been obliged to retire before a monitor, but she had not been much damaged by the 11-inch guns, although her armour was only 10 c/m. (4 inches) thick. But the 'Tennessee's' battery was protected by armour of 15 c/m. (6 inches), a thickness of armour which had not yet been pierced. He knew that his ship was invulnerable, not only as regards the 9-inch guns and those carried by the wooden ships, but also as regards the 11-inch Dahlgren guns carried in the monitors. There was no reason to be alarmed by the abortive attempts which the wooden vessels had made to ram his ship; on the contrary, he was sure he could destroy them one after the other. There was only one vessel in Farragut's squadron, whose guns he need fear, those of the 'Manhattan,' but there was not a naval officer who at that time believed that 15-inch guns could penetrate through armour of 15 c/m. (6 inches)." Judging, then, from the data at hand, had not Admiral Buchanan fair reason for believing that he should be able to destroy a large portion of the Federal fleet before being himself reduced to surrender? . . . .'

Signor Brin.

When the 'Tennessee' was seen to approach, the Federal ships loosed their anchors, and prepared for action. Farragut's intention was to fire into and ram the enemy. The necessary orders were given, and the ships advanced to their dangerous work. The 'Monongahela,' a large corvette of 1,400 tons burden, armed with several 9- and 11-inch guns, bore down at full steam upon the 'Tennessee,' rammed her with considerable force, and fired her guns within a few feet. The 'Tennessee' was not in the least damaged, but the corvette had her ram shattered. Immediately after, the 'Lackawanna,' a screw corvette of the same size, rammed down at full speed into the 'Tennessee's' broadside. The concussion produced by the shock started the corvette, and, beginning to fill, she retired. The 'Tennessee' had received no injury, and meanwhile was doing great execution with her guns, though her own attempts to ram also failed.

The 'Hartford' then attempted to strike the 'Tennessee,' but the latter avoided the shock, and the ships touched sideways. The 'Hartford' fired her whole broadside at a ten-feet range, without producing any effect. The 'Tennessee' replied with her two guns; one missed fire, but a shell from the other went through the 'Hartford's' side and burst, killing and wounding many of the crew, and doing a great deal of damage. The 'Hartford' endeavoured to disengage herself in order once more to ram the 'Tennessee,' but instead, was herself struck by the 'Lackawanna,' which sank from the shock. The screw ship 'Brooklyn' fired her 9-inch guns at the 'Tennessee' without result, but was herself considerably injured by the 'Tennessee's' return fire; whilst another Federal screw ship, though seriously suffering herself from the 'Tennessee's' fire, could do nothing to return it.

The two armoured monitors of Farragut's squadron, the 'Chickasaw' and 'Winnebago,' now came up, and opened fire with their 11-inch guns, but without effect. Then at last the third monitor, the 'Manhattan,' advanced with her 15-inch guns. A 15-inch shot struck the 'Tennessee's' casemate, penetrated through the armour of 15 c/m. (6 inches) and imbedded itself in the backing. Three more shots were fired, of which one penetrated through and broke the steering-wheel; another jammed the armour of one of the ports so seriously as to render its gun unserviceable. So that the 'Tennessee,' after gallantly fighting and spreading destruction all round, was at last obliged to strike her flag and surrender.

After the 'Tennessee' had fallen into the power of the Federals it was ascertained that no fewer than nine 11-inch shots had struck the rear of her casemate, over the restricted surface of a few square

feet, without penetrating; and that in the centre of her casemate between the two ports, a solid 15-inch shot had completely shattered the armour and backing, displacing inside a compact mass of timber of about three feet by four. This was the only shot which necessitated the surrender of the ship. Signor Brin.

From this account we learn that Admiral Buchanan, who had already experienced the relative power of armour-plating at New Orleans, when he had to face, with four armour-plated ships, a fleet of seventeen powerful vessels, of which three were ironclads, left behind the three ironclads which were insufficiently protected, considering it wiser to trust to the one vessel which was protected with 15 c/m. (6 inches) of iron plating, a thickness which he considered could not be penetrated by the enemy's guns.

If he was deceived, it must be remembered that he was unaware that there was *one* gun aboard the enemy's fleet which *could* pierce his armour.

Fourteen screw ships and two ironclads attacked Buchanan's one ship with their guns and rams, and only ended in hurting themselves; but on the arrival of one ironclad with 15-inch guns, one single shot from her guns sufficed to reduce the enemy and save the other ships from disaster. . . .

The naval actions fought between the Chilians and the Peruvians have been confirming the results of the American war. The small Peruvian monitor 'Huascar' sank several Chilian ships, which, according to the first accounts, included one ironclad, though it was afterwards ascertained that this ironclad had foundered through striking a rock. However, there immediately sprang up in England a cry in favour of small ironclads. The *Times* called for the construction of ships like the 'Huascar.' 'Huascar.'

Fortunately, a few days after the 'Huascar' encountered the Chilian ironclad 'Almirante Cochrane.' The little 'Huascar' tried to ram, and failed. The larger and faster 'Cochrane' always kept the 'Huascar' under the fire of her heavy guns, and took possession of the 'Huascar.' . . . Speed.

With the notion of size is generally attached the attribute of slowness, laziness. The 'Duilio,' with her 15 inches, is the fastest ironclad we have, and she can turn in a circle of a diameter of 380 metres, that is, in a smaller circle than all our other ironclads. . . .

The Austrian ironclad 'Kaiser Max,' which struck and sank the 'Rè d'Italia' at Lissa, circled with a diameter of 977 metres, taking nine minutes to complete the circle, with a speed of nine miles; but

Signor Brin.

the 'Duilio,' with a circle of 380 metres, completed in five minutes at a speed of 15 miles, is declared to be a bad ram! . . .

Let us pass to the question of speed.

To dispense with speed is to renounce and give over to others that great advantage of being able *oneself* to decide whether one will fight or will not fight; the faculty of having it in her own power to determine when, how, and where she will fight; to choose which and what sort of ships she will pass, isolate, or fight. To adopt such a naval policy would, for a Navy of the second order, be to renounce all hope of being able to fight, with a chance of success, against a Navy superior in point of numbers. . . .

Draught of water. Maldini.

According to Maldini, the great draught of our four largest ships is their great fault. . . .

England has constructed the 'Inflexible' with the special object of being able to make the passage of the Suez Canal. . . .

I have wearied myself in seeking what interests we have to defend against maritime Powers beyond the Suez Canal. To defend our incipient commerce in Africa against the small states unprovided with a Navy, we have plenty of ships—even ironclads—which can pass through the Suez Canal. . . .

Dimensions with reference to use of ram.

But let us consider now another point raised in argument by Signor Maldini.

'Let us consider,' he says, 'the probable result of an engagement between a gigantic vessel and two ironclads of ordinary dimensions. What will happen in such a case? The gigantic ship will charge with the ram one of the ordinary ships, and will sink her without doubt; but will she at the same time be in a position to defend herself against the ram of the other ironclad? I think not; on the contrary, in executing the first charge the gigantic ship will present the best possible mark to the enemy, and will be in the position the best adapted for being rammed by her.'

Signor Maldini, it may here be observed, shows himself exclusively a partisan for fighting with the ram, since he hardly mentions cannon, and is altogether silent on the question of torpedoes. He assumes that the 'Italia' charges against one vessel of the group, and that at the same moment another vessel charges and sinks the 'Italia.' It must be pointed out that this is a tissue of gratuitous suppositions.

The group cannot overtake the single ship. She can always be mistress of the situation, and maintain herself in front, in the

rear, on the flank of the group, at whatever distance she pleases, by changing these positions, by approaching nearer or drawing away from the group, in order to attack one of the vessels. This certainly constitutes a great advantage, not hypothetical but real. . . . *Signor Brin.*

What will those say who consider the ram the chief mode of attack, the powerful artillery to-day, and when they look to the torpedo, so felicitously called by a French Admiral the spur, of some hundreds of metres in length? Before these powerful and murderous weapons were invented, even naval men were inclined to consider the ram as the principal means of attack.

I recollect that in 1860, as captain of frigate, San Bon was sent to England to study the question of ironclad ships. In a report to the Government he detailed his ideas of the 'ram,' and this report resulted in orders being given for the 'Affondatore,' a ship of great speed, and especially constructed with the object of attacking the enemy's ships.

But he who in 1860 was the supporter of ships armed as it were only with the 'spur,' changed his opinion when he saw the 100-ton gun, capable of crushing the largest ironclads, and the insidious torpedo, with its speed of 26 miles an hour: the torpedo, which, as we have before said, may justly be compared to a spur of 300 metres long. . . .

It is worth while briefly to relate the studies of the Council with regard to the construction of the new ships. *Council on Construction, 1878.*

When I was Minister of Marine, at the end of 1877, I charged the Council to take into consideration the laying down of a new line-of-battle ship.

Availing myself of the power given me by the decrees by which the Council was instituted, I considered it advisable, on account of the gravity of the question, to add some naval officers to the ordinary members.[1]

The Council being thus reinforced, determined, as the basis of its

[1] The Council on that occasion was composed as follows: —

Vice-Admirals . . .	Di Brocchetti, President Di San Bon
Rear-Admirals . . .	Bucchia and Fincati
Post-Captains . . .	Albini, Director-General of Artillery Caimi, Director of Artillery, 1st Dep. Lovera, Director of Artillery, 2nd Dep. Tilling, Director of Artillery, 3rd Dep.
Inspector of Shipbuilding .	Mattei
Four directors of Shipbuilding .	Michele, Pucci, Torre, Vigna

Signor Brin.

studies, to ascertain the smallest ship that could be made consistently with preserving all the qualities indispensable for a line-of-battle ship. Since the time the 'Italia' was planned, many improvements had been introduced into machinery. It was therefore determined to adopt engines of a newer and lighter type, and thus was established the first reduction in the size of the ship. It was unanimously resolved to retain guns of 100 tons weight.

It was known that France had passed from guns of 48 tons to 72 tons, and it was agreed that it would be a great error for us to go backwards. But though the Council decided not to go below the 100-ton gun, they determined to reduce the number of guns to two. This was a return to the armament originally projected for the 'Italia.' It was further decided to make a reduction in weight of machinery. In 1878, in conformity with these instructions, the plan of the new ship was prepared. It was to be sensibly smaller than the 'Italia' or the 'Lepanto.' . . .

What was it then that the Superior Naval Council did in 1878?

It recognised that the power of offence did not consist in the number but in the calibre of the guns; it maintained the calibre, but reduced the number.[1] . . . .

But in spite of this, the Superior Council having taken into con-

[1] In order to show how true it is that by diminishing the size of a ship her power is enormously reduced, I will compare the two English ships, the 'Inflexible' and 'Agamemnon'; they are of the same type, so much so that the 'Agamemnon' was called a reduced 'Inflexible'; they were both designed by the same constructor. These are the chief particulars of the two ships:—

	'Inflexible'	'Agamemnon'
Displacement	11,600	8,640
Number of screws	2	2
Number of revolving turrets	2	2
Thickness of armour-plating at water-line: inches	24	18
Thickness of turrets	17	16
Number of guns	4	4
Weight of each gun: tons	80	38
Weight of projectile: lbs.	1,703	818
Weight of charge: lbs.	450	130
Total force of projectile at muzzle: foot-tons	29·663	11·357
Perforating force of projectile at muzzle: per inch of circumference	591 foot-tons	289 foot-tons
Thickness of iron armour-plating they could penetrate at muzzle	? 28 inches	17·2 inches
Speed in miles	14	13

Having thus reduced the size of the ship, and hence its cost, you have a vessel with one mile less speed, with armour-plating of 18 inches instead of 24, with the same number of guns, but a power less by one-half.

The 'Inflexible' can penetrate the plates of the 'Agamemnon' at 2,000

sideration every legitimate desideratum, came to the conclusion to construct a smaller vessel, which relatively to its fighting powers would cost more; but they did not arrive at the conclusion of wasting money by constructing a vessel which would not satisfy all the essential requirements of a line-of-battle ship. *Signor Brin.*

On this occasion two officials took a still more decided view. Admirals San Bon and Fincati proposed for consideration a ship of reduced tonnage which should be armed with only one gun of 100 tons. The great majority of the other officials opposed so great a reduction in the armament of the new ships.[1]

Subsequently the Minister of Marine, Admiral di Brocchetti, sent Inspector Mattei and myself to France and England in order to examine the prevalent ideas in those countries with regard to ironclads and their armament.

When our mission was accomplished, the Superior Naval Council, with whom were associated many distinguished officers, was again called together by the Minister di Brocchetti, to consider the plans for our new line-of-battle ships.

On this occasion Inspector Mattei and myself were called on to state the impressions we had gained in France and England. We both stated (see long discussion in Italian Chamber on question of Estimates), that in France as well as England the prevailing opinion was in favour of more moderate sized ships. In France it was decided not to go beyond guns of fifty tons weight, and to construct ships of 9,500 tons displacement, instead of the 'Duperré,' which is over 11,000 tons. In England the same idea prevailed, and the new ships would be smaller than the 'Inflexible,' and about the same size as the French, viz., 9,500 tons.

At that time I gave the same information to the Chamber in a discussion on naval matters. The Supreme Council discussed the question at length, and in spite of the example of England and France, considered that our Navy, after having introduced into our ships 100-ton guns, after having overcome all the difficulties of fixing and working them, ought not to make a retrograde movement. In their judgment, when a large gun had been introduced it was imprudent to adopt a smaller gun, and run the risk of finding our-

metres. The 'Agamemnon' cannot penetrate the 'Inflexible' at even the shortest distance. If a comparison is made between the fighting power and the expense, one sees how much more costly the 'Agamemnon' is, and she is absolutely helpless against the 'Inflexible.'

[1] The English already acted on this idea by laying down in their dockyards the ironclad 'Conqueror,' with only one turret.

Signor Brin.

selves opposed to an enemy with a more powerful weapon. If it was necessary to come to a compromise with regard to the number of the guns, it was imprudent to do so with regard to their individual power.

The Superior Council then, at the end of 1878, resolved to reduce the armament of our new line-of-battle ships to two guns of 100 tons, and to adopt engines of the most recent and lightest type.

It was intended in the revised programme to obtain a ship with the armament originally proposed for the 'Italia,' and with her other qualities, but distinctly more economical and smaller, from 11,000 to 12,000 tons.

The following is the programme then formulated, and which I take from the Acts of Parliament (October 25, 1878):—

Artillery . . .	Two guns of 100 tons, with mechanical appliances protected by armour-plating
„ . . .	Guns of small calibre for canister shot
Masts . . .	None
Speed . . .	Equal to the 'Italia'
Coal-supply . .	About same as 'Italia'
Armour-plating . .	On system of 'Italia'
Number of decks . .	Two; one of sufficient height to carry horses

The Council which composed this programme were as follows:—

Vice-Admiral Di San Bon, President.
Vice-Admiral Cerruti.
Rear-Admiral Bucchia.
Rear-Admiral Fincati.
Rear-Admiral Ferdinando Acton.
Post-Captain Albini, Director-General Artillery.
Post-Captain Merlin.
Inspector of Shipbuilding Mattei.
Inspector of Shipbuilding Brin.
Director of Shipbuilding Micheli.
Director of Shipbuilding Pucci.
Lieutenant Parent, Secretary.

Ferracciù having come into power in March 1879, the armament of the 'Italia' was reconsidered, and the adoption of the 100-ton guns was confirmed, all our officials being convinced on this point. . . .

Views of French Naval Administration.

It was in 1878 that our Superior Council persevered in the opinions first proposed, in spite of the fact that France and England had somewhat retreated, the one from the 'Duperré' the other

from the 'Inflexible.' This consideration, which in spite of its gravity did not move our Admirals, exists to-day. *Signor Brin.*

In the discussion on the French Estimates, the Minister, Admiral Pothuau, to the reproach that vessels of an inferior type to those of other navies had been laid down, replied: 'If we have not been as prompt as other nations in the construction of the largest ships, it is because during some time it has been believed undesirable to exceed the type of the "Duperré," that to go beyond this would be an exaggeration, and all the more so because there was a great question of doing without armour in ships.' These words confirm the information to which I have alluded above, and of which I had the honour to inform the Chamber.

For some time it was considered in France that to go beyond the 'Duperré' (of the size of our 'Duilio') would be an exaggeration. At that time, in spite of the current of opinion, in spite of the consideration that these opinions had prevailed in France and England, our naval authorities persisted in their own course, and now we see that France at least considers that we were right.

Let us continue the explanation of Admiral Pothuau:—

'The armourclad of the first rank in 1872 is no longer the ironclad of the first class of to-day, any more than was that of the preceding periods. In 1872 we were content to give them a thickness of armour-plating of 30 c/m.; the last ironclads laid down have 55. To-day the ironclad of the first rank has guns of 74 tons, while waiting for those of 100 tons which have become indispensable. It is necessary that as these ships disappear on account of age, they should be replaced by others which answer to the ideas and necessities of the time in which they have been laid down. This rule is followed in England and in Italy.'

Let us compare these last words with the programme proposed in 1875 by San Bon:—

'This is the system that I intend to follow; it consists in examining when a vessel is laid down in the dockyard in what direction the course of progress is tending; in forecasting at the time when this vessel is to be launched, what will then be the prevalent ideas, assuming the general progress that has taken place. This system appears to me to be the only sound economical and acceptable one for a country that has faith in itself. . . .'

The Minister of the French Marine continued thus: 'We might put guns of 100 tons on the "Duperré;" the question has been considered, but we give it up for the time: we shall reconsider this decision perhaps later on. But we have two ships which are on the

Signor Brin. point of being laid down, the one will be called the "Formidable," the other "Amiral Baudin"; these ironclads of the first class will be armed with three guns of 100 tons each; there is a necessity for providing for these armaments, which force themselves upon us. . . .'

We see then that one of the principal navies of the world undertakes the construction of a ship the same size as the 'Duilio,' namely the 'Duperré,' with armour-plating of 55 c/m., and guns of 100 tons, and announces that it will put new ships on the stocks according to this programme, and that in 1885 she will have nine ships armed with guns of 50, 74, and 100 tons; that perhaps on some of these ships 100-ton guns would be substituted; but at any rate she will have in 1885 seven ships with armour-plating of 55 c/m. . . .

'Polyphemus.' I mentioned a little before the ram 'Polyphemus,' which the English are constructing. This 'torpedo-ram,' as it is called, will be scarcely visible above the water. It will have an ironclad deck. It will carry no guns, but will have a powerful ram, and appliances for launching torpedoes from the prow and flank. These terrible means of offence will be rendered still more formidable by the high speed of the ship, which it is calculated will reach 17 miles.

The 'Polyphemus' will not be a man-of-war in the true sense of the word. The English Minister of Marine said of her: 'She will not be able to undertake long voyages, but I think she will be a very formidable adversary, and perhaps a rival for the large ironclads which are in course of construction.' But which of these ironclads need have no fear from this enemy?

Only those, certainly, like the 'Italia,' which have a superior speed to the 'Polyphemus,' and powerful guns to attack her, while keeping at a distance from her insidious attack. . . .

These 'Polyphemuses' are the 'Affondatore' of our time, that is to say, improved rams with apparatus for launching torpedoes, *i.e.*, repeating the exact expression of a French Admiral, 'Rams with a spur of some hundreds of metres in length.'

The celebrated American, Admiral Porter, who took so great a part in the war against the Secessionists, wrote in 1873 to his Government: 'I am confirmed in my opinion that the torpedo, although still in its infancy, is destined to occupy a great position in future naval wars. England makes great progress in the use of this arm, which can destroy any kind of ship. But if the use of this weapon is understood, if you have a vessel of equal speed, torpedoes may be avoided. A torpedo vessel with an iron deck, and with the crew below, so that the small guns would have little effect, and which would offer less mark to aim at, while the solid projectiles would often glance off

from the ship' (this is a description in anticipation of the 'Polyphemus'), 'would be a formidable adversary, from which there would be no means of protection except for vessels of superior speed.' *Signor Brin.*

This new and formidable weapon of war, foretold in 1873, now makes its appearance, but within a little while it will not be alone, but all navies, including, I hope, our own, will be supplied with it.

What, I repeat, in the presence of the 'Polyphemus,' would the new ships do, with their moderate speed and moderate guns?

The more I reflect on these changes in modern navies, the more just appears to me the opinion of Admiral Prince de Joinville, 'It is not necessary for me to repeat it; the condition of success is speed, speed.'

. . . .

I hold that it is a mistake to first of all determine the size of the ship, and although I have already quoted some examples of the inconvenience of having followed this system, I will quote some more recent ones, which bear upon our case. **Views of English naval authorities.**

In 1870 a commission of inquiry was appointed in England in order to examine the various types of ships which were constructed for her Navy.

Naturally, even in this great Navy, there were many defects and imperfections even in her new ships.

I will now quote what Vice-Admiral Robinson, who was then Controller of the Navy, and to whom England owed the construction and superiority of her new ironclad fleet, wrote to the Commission.

It would be difficult to find a more experienced or impartial judge than this Admiral, although some consider that constructors have a prejudice in favour of large ships.

These are his words:—

'It is a common thing to desire a naval constructor to prepare the plan of a vessel whose size and tonnage are limited to arbitrary figures, with a maximum speed, certain weight of armour-plating, armament, sailing power, sea-going qualities, and finally small draught of water.

'The inevitable result is that the constructor has to make many compromises, and can only produce a plan, which is not the best, but only the least faulty, regard having been had to the conditions imposed on him.'

. . . .

Our experience, then, as well as that of the English, concur in demonstrating how illogical it is to commence with determining the size of the ships, instead of first of all deciding what is required of the ships themselves.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION II.

ON THE NECESSITY FOR SPECIAL TYPES FOR THE EFFICIENT PERFORMANCE OF THE VARIOUS SERVICES UNDERTAKEN BY THE NAVY.

SPECIALISATION OF TYPES.

Sir Spencer Robinson.

Sir Spencer Robinson. — May 1870.

An armour-clad turreted Navy must consist of two distinct types—the high freeboard cruising ship, and the low freeboard non-cruiser, unhampered by masts. Each will have made a compromise, but the smallest possible, of some valuable qualities of a perfect ship, but each will have obtained as a weapon fitted for special service the greatest amount of perfection of which naval constructions are capable.

Mr. Scott Russell.

Mr. Scott Russell. — 'England without a Navy.' Paper read at the United Service Institution, June 1877, and Sir Spencer Robinson's observations.

Mr. Scott Russell laid great stress on the necessity of a British fleet, consisting not of vessels of one type for one peculiar service, but of sundry kinds of vessels for a variety of uses. In this he was fully supported by the late Controller of the Navy, Admiral Sir Spencer Robinson, who forcibly remonstrated against the imperial necessities of our world-wide dominion being subordinated to the exceptional requirements of ephemeral enterprises. Let us, by all means, respect and use torpedoes, but remember that they cannot do everything, and will be comparatively useless without guns to protect them. Let us multiply gunboats for local purposes, but the dominion of the sea cannot be maintained by mosquitoes. Let us, without fail, provide our ships with rams, but torpedoes may prevent the employment of this weapon when artillery can still be effectually employed. Let us have many ships, of great coal-carrying capacity, to protect our colonies and commerce, but let us also have shallow draught vessels for river and harbour defence. Let us have small boats to carry torpedoes by night, but let us not forget that these weapons can be used by every merchant vessel and every ship of war by day as well as by night, for their own defence as well as for attack. These and many other classes of weapons and vessels of war we must

have, in all their variety and in great number, if we would constitute such a fleet as the country may depend upon, not for safety only, but for national existence. *Mr. Scott Russell.*

Sir Thomas Symonds.

Three squadrons are necessary—a sea-going set of ships, for the protection of commerce, a fighting set of ships, as fighting machines, as a Channel fleet, for the defence of the country, and an along-shore squadron for the defence of Liverpool, Glasgow, Spithead, and so forth. *Admiral Sir Thomas Symonds, K.C.B.* — *Times.*

Admiral the Earl of Hardwicke.

We must have three fleets: (1) a fleet for the defence of our coasts and for blockading purposes. A turret-ship is the vessel best suited for this service. It is only on a centre turntable that you can carry those large guns which cannot be carried as broadside guns; (2) a fleet of large vessels, suitable for cruisers, to act as convoys, and to keep a look-out. They should not be armoured. If armed with heavy artillery, it must be placed on a turntable; (3) a fleet must act in masses. You will be assailed in masses, you must defend in masses, and must cruise in masses. *Admiral the Earl of Hardwicke.* — Speech at Institute of Naval Architects, Session 1878. Transactions, vol. ix. pp. 152–3.

The line-of-battle ship—what is she to be? She need not be very fast. She should have plenty of lifting, bearing, and floating power.

Commodore Goodenough.

It is probable that the duty to be performed by our armoured ships in a war with either of the great naval Powers, France or America, will be:— *Commodore Goodenough,* — Enclosure in Admiral Warden's report for 1868. Published in Parliamentary paper on ships in Channel Fleet.

(1). Protection of our colonies and military stations, and attack on those of the enemy.

(2). Blockade of an enemy's port, containing ironclads.

(3). Attack on an enemy's squadron, convoying troops or supplies, or proceeding to attack our colonies.

For the first duties the turret system is the best that can be devised, on account of the complete defence that it offers, and the ease it affords of fighting heavy guns.

In the second case, it would be absurd to suppose that an inferior class of armoured ship, unless in very superior numbers, could stop the exit and ravages of a superior class. The turret-ship, in port,

Commodore Goodenough.

can choose her weather, and can come out to attack at her own time. She can only be blockaded by a turret-ship.

There remains the case of a real sea-fight between fleets. Ships for this purpose, to be efficient for the varied and extensive range of sea-duty they will have to perform, should have high speed, quick turning power, heavy armament, and great stowage of fuel.

Captain Colomb, R.N.

Captain Colomb, R.N.

United Service, April 8, 1871. On the attack and defence of fleets.

If I were to make the assertion that the designs of our ships arise more out of instinct and tradition than out of any comprehension of how they are liable to attack, and how they are capable of defence, I should at first raise a feeling of incredulous surprise in the minds of my audience. . . . But who can say of any ship in our Navy in which the two weapons are combined, that her gun-power is properly sacrificed to assist her ram as the superior weapon, or that her ram-power is judiciously curtailed to admit of increased ordnance? . . . Then if the ram be alone considered, what are the relative values of speed and turning powers for attack upon a willing adversary, or for compulsory defence? May speed be judiciously sacrificed to turning powers, and to what extent? Or must speed be secured at all hazards, and turning powers only considered afterwards? . . . The 'Monarch' has the fewest and heaviest guns of any sea-going ship in the Navy, and she exercises her gun-power over a larger arc than any other. She is the embodiment of the idea that the gun is the decisive weapon at sea, to which all others must give place, and that this weapon is the most powerful when mounted in limited numbers, of the greatest size, and with the largest arc of training.

Mr. Barnaby, C.B.

Mr. Barnaby, C.B.

Annual of the School of Naval Architecture, 1872.

Such a Navy as that imagined would consist of three great divisions—coast-defence vessels; ships capable of taking part in an engagement with a fleet which would otherwise blockade a harbour, or bar an important line of traffic; and lastly, vessels capable of keeping the sea for long periods, of engaging privateers, and making reprisals on the merchant ships of an enemy. . . .

The first class, those for coast-defence, should be capable of being worked by the seafaring population of the ports to be defended, in conjunction with the local steam shipping.

The second class need not be cruising ships, but may have everything thrown into efficiency under steam in battle.

The third class must be fast-cruising ships, economical in fuel and in men. All of them must be designed to suit local peculiarities of climate and of seaboard, and the furnaces should all be adapted to burn local fuel, so that we may no longer have to send English coal to Canada and India. *Mr. Barnaby, C.B.*

OPINIONS OF THE PRESS.

The 'Times.'

THE 'RUPERT.'

Although this vessel has been designed for special service, and her armament has been reduced to give full effect to her ramming power, she is as powerfully protected by armour-plating as any iron-clad in the service, for she has a belting two feet above water and five feet below of 12-inch armour, fixed to the same thickness of teak, and an inner skin of iron $1\frac{1}{4}$ inch thick. But she is what she was intended to be, a compromise; and much as she will be discussed this Session, she will fairly illustrate the principle laid down in the Report of the Committee on Designs, that modern ships of war must be a compromise. Her elements are numerous, and are worth enumerating, if only to show the difficulty of constructing a perfect ship. Such a ship must float, have great speed, be handy, and, therefore, as small as possible; be well protected by armour in case of attack, carry an effective armament, and yet in no wise such as to prejudice her utility as a ram. This is as much as saying that she must have a high and a low freeboard, have immense speed, yet be small in size; and, with this speed, must, nevertheless, be protected by the heaviest armour-plating and carry the heaviest guns. Yet modern critics demand that the Navy shall possess vessels combining these anomalies, and argue as though the Navy were worthless because the most opposite conditions cannot be combined in one vessel. So Mr. Reed determined, apparently with good judgment, to separate the ram from the gun vessel, and has set the example in the 'Rupert' of building special vessels for special purposes, giving up the idea of uniting in one form of vessel every necessary quality in a man-of-war. We cannot have better examples than in the 'Rupert' and 'Devastation.' The 'Rupert' is built as a ram, the 'Devastation' as a carriage for using the heaviest guns known. In the first class of vessels, the ram, all qualities are useless without *Times, March 1872.*

Times. speed, and powerful armour for protection against attack. But handiness enters as a secondary qualification, which must be attended to. Now speed and handiness, especially when heavy armour is another necessity, are difficult qualities to combine. In fact, with such conflicting requirements, a vessel like the 'Rupert' is severely handicapped. To obtain both handiness and speed some sacrifices must be made, and in the 'Rupert' the necessary penalty has been paid. To be handy, an armoured vessel must be small; to be swift, a heavily-armoured vessel must be large; the 'Rupert' is, necessarily, a heavily-armoured vessel, so two apparently irreconcilable elements have to be adjusted. Mr. Reed determined to combine these conflicting necessities, and did not hesitate to sacrifice the guns. So the armament of the 'Rupert,' which is as heavily protected by armour as any vessel in the Navy, is very meagre, consisting, as we have already said, of only two 18-ton guns. But, having accepted this compromise, it was then possible to strengthen her as a ram, with every device which ingenuity could suggest, and to protect her with 12-inch armour, but at the same time to reduce her size to such an extent as to make her a handy yet swift vessel. For, after all, she is only 253 feet in length by 53 feet in extreme breadth, while her burden is only 3,159 tons.

Such a vessel is, to some extent, a novelty, and, until her steaming powers are tried, it is impossible to give a definite opinion upon her merits. She is built on a sufficiently intelligible plan, and for a sufficiently distinct purpose, to corroborate the opinion that she contains several elements of success, but, like all other freeboard vessels, her success depends primarily, if not wholly, on her power of floating. For the special service for which the 'Rupert' has been designed no justification is needed. Since the battle of Lissa, ramming has become an essential element in naval warfare; and the efforts produced on that occasion give but a faint idea to what extent ramming may be carried. All we can hope is, the 'Rupert' will never have occasion to test her powers; for, if she has a fair chance, her adversary will have a bad time of it.

'*Broad Arrow.*'

COAST-DEFENCE SHIPS.

Broad Arrow, September 25, 1875. The application of armour-plating to the sides of ships for the purpose of protection has resulted in great variety, both in the modes or construction and arming, as well as in the functions for which

different ships are intended. In the days of our wooden walls ships differed merely in size and in the number of their decks. All were built for keeping the sea; all were equally adapted for offensive service abroad and defensive service at home. But the invention of the ironclad has changed all this. Ever since that monster came into existence the problem to be solved has been: What is the best manner in which to fashion and arm him? and How can his services be best utilised? This investigation commenced by multiplying types of the frigate class, and was continued in a disputation regarding the relative merits of the turret and broadside systems. Common consent appears to be now given to the opinion that the broadside ship is best adapted for performing service in distant seas and for acting in line of battle, whereas the turret system affords splendid facilities for constructing coast-defence ships. This conclusion was not arrived at by very rapid stages. It required years of slow progress before the truth dawned upon us. Neither was the investigation unattended with cost. No less a loss than that of the 'Captain,' with her unfortunate crew, was required to convince a clamorous press that a turret-ship of low freeboard is not capable of carrying sail; and the expense of building the 'Monarch' was necessary to prove that a turret-ship of high freeboard is a far from economical engine of war. The result of this selective process of development has been the division of the fleet into two distinct classes of ships, viz., those for service abroad and those for defending our coasts. *Broad Arrow.*

'*Fraser's Magazine.*'

Three distinct classes of fighting vessels appear to be required for the various duties of war and peace, which we have in general terms described. We want— *Fraser.* March 1871.

1. Heavy-armoured ships of large size and of deep draught, fit to fight in line of battle, or to break into an enemy's port or arsenal;

2. Small armoured ships of light draught and high speed, for the protection of our coasts and of important strategical positions in the colonies, aided by gun-boats which need not carry armour; and,

3. Light squadrons of unarmoured corvettes and frigates, of the highest speed attainable, for police of the seas in peace time and escort of trade in war time, with swift despatch-boats for look-out purposes.

FOREIGN AUTHORITIES.

Lieutenant Semechkin.

Lieutenant Semechkin. — 'Tactique Navale.' Lecture delivered at Cronstadt, 1868. Republished in *Revue Maritime.*

We shall divide the greater number of our ships into squadrons, not so much in accordance with the number of ships which constitute them as with reference to their types and individual qualities. . . .

We shall have a squadron composed of monitors, another of broadside ships, and another of turret-ships.

The division of ships into squadrons with reference to types is easily carried out. The Admiral would then have under his command two or three groups of ships possessing the necessary offensive and defensive qualities. And he will be able to employ his forces in masses, either for attack or defence, in the execution of his general plans of naval strategy. He will have a division of rams to attack with the spur, and a division of turret-ships furnished with a powerful artillery for an engagement with guns alone. Experience will show to what point this system of subdivision is advantageous. But we have reason to expect that on the whole the result will be beneficial, since it is based on the principle of homogeneity, which is undoubtedly sound.

Admiral Touchard.

Admiral Touchard. — Extract from pamphlet, *La Question du Décuirassement.* Paris, 1872.

In view of a war with England, it would be necessary to provide for a triple eventuality—to fight an engagement on the high seas, to make war on the coast, and to harass the commerce of the enemy. Ships of distinct types would be required, for the line of battle, coast service, and privateering operations. The scene of the most serious wars which could possibly occur in the immediate future would be near the coasts of Europe.

Admiral Touchard sums up his practical conclusions as follows:—

Assuming that the battle-field of future naval struggles will be less distant than in former wars, he considers the 'Devastation' type will be found, under the conditions presupposed, the most powerful and effective. He considers, further, that the fleets of the future must be composed of two types—the mastless 'Devastation' class, and the masted ship without protection for the guns. These two types, in combination, each supplying what is wanting in the other, will constitute, in his opinion, the squadrons of the future. The one

point on which he is absolutely convinced is that the masted armoured ship will soon disappear as a fighting vessel.

Admiral Touchard.

Admiral Touchard returned to the same subject in a subsequent pamphlet, and reiterated the same view of the shipbuilding policy of the future.

Encore la Question du Désarmement. Paris, 1876.

'An armoured fleet intended for the line of battle should be composed of ships of the "Devastation" and "Inflexible" type, completely armoured, and of masted ships, armoured at the water-line only. The mastless ship would carry 20-inch armour at least, and would be armed with guns of the greatest power. She would be fitted with the ram, would possess high evolutionary qualities and be capable of steaming 14 knots, and would carry a large supply of coal. The other type would be a masted ship, also of a speed of 14 knots, protected at the water-line only by a belt of armour, having an armour deck, and mounting ten or twelve guns of from 27 to 24 c/m. I may add that if I were asked with which of the two types the Navy should be supplied, I should incline in favour of the mastless armoured ship.'

M. Marchal.

M. Marchal.

Revue Maritime, January 1878, p. 186.

In France, the execution of the new programme of battle ships was seriously taken in hand in 1873 and 1875 by commencing the construction of nine ships divided into three principal types and conceived under a single inspiration, and with a distinct unity of purpose. We insist on this point all the more, inasmuch as the result has been the distribution of the different qualities desired between the three types, in such a manner that the one is a complement of the other; and that we have no duplication of parts. Each type of ship is intended for a special service. The 'Redoutable' type is intended for doing battle on the high seas, the 'Tonnerre' type for attacking the coasts of an enemy, the 'Tempête' type for the defence of the coasts of our own country. These types are distinguished from one another by the adoption of three distinct draughts of water. For the first class, 25 ft. 4 in.; for the second class, 21 feet; and for the third class, 16 ft. 9 in.

In England the stern draught most commonly adopted for vessels of the line is 26½ feet, which is the draught of the 'Hercules,' the 'Devastation,' the 'Alexandra,' &c. On the other hand, the vessels of the 'Tonnerre' class, three in number—the 'Glatton,' the 'Hotspur,' and the 'Rupert'—have a minimum draught of 21 feet.

Reprinted from the 'Broad Arrow.'[1]

Broad Arrow.

In times past the fighting power of a ship of war was measured by the weight of metal thrown by her broadsides. Obviously, the old standard is no longer applicable. What, then, is the true measure of fighting power in the present day?

The fighting powers of a vessel of war are dependent on:—1. Her gun-power. 2. Her degree of invulnerability in regard of ramming and projectiles. 3. Her speed. 4. Her handiness in manœuvring. 5. On the powers of her spur and torpedoes. 6. On the absence of rigging, which, by its fall in action, might foul the screw. 7. On her sea-going qualities enabling her to engage without tactical disadvantages in all weathers. 8. On the skill and capacity—general as well as special—possessed by her commander and crew. Ships designed for special duties should possess, in addition, the special qualities requisite for the accomplishment of such duties. Thus, ships for coast-defence should have a light draught of water, so that all the channels and refuges along the coast may be accessible to them. Ships designed for naval sorties and sudden attacks should be, as much as possible, invisible at night; ships for ocean cruising should be good sailers, and carry an ample store of provisions, &c.

Passing by the qualities indispensable to the performance of particular duties, let us examine, rather more closely, some of these elements of fighting power, so that we may recognise more clearly the inconsistent nature of the conditions which admit of an increased development of particular qualities. 1. The gun-power of a vessel is dependent on—the calibre and description of her ordnance; the number of her guns; the ease and expedition with which the latter can be worked, and their angles of fire.

Pieces under a certain calibre—small-bore guns more especially — may be regarded as useless against ironclads, as an increase in their numbers produces scarcely any augmentation of the tactical power of the vessel. High gun-power implies heavy weight; and this, together with the arrangements necessary for fitting and working the guns, causes an increase of gun-power in any particular vessel to be accompanied by a very considerable increase in her draught of water. Consequently, it is only ships of very large size that can carry any number of the heaviest guns. But an increase in the dimensions of a ship causes a loss of turning power and handiness in manœuvring. It is only at the sacrifice of sea-going qualities

[1] **Translated from the Russian in the *Revue Maritime et Coloniale* for April 1873.**

and speed, that we can place heavy armaments in vessels of small size. *Broad Arrow.*

2. To increase the invulnerability of a vessel, it is necessary to protect her with heavy armour. Heavy armour involves loss of manœuvring power. On the other hand, invulnerability to ramming depends on speed and turning power; to increase the manœuvring power a decrease in the size of the vessel becomes necessary. Here we see that invulnerability at all points would suppose the co-existence of two diametrically opposite conditions—an *in*crease and *de*crease in the size of the vessel. Rigging diminishes invulnerability, as a vessel with masts may easily be deprived of the latter, and so rendered powerless in action.

3. The speed of any given vessel depends immediately on the power and height of her engines, so that she would attain the maximum speed possible for her if she carried her machinery alone. To armour a vessel of given dimensions, possessing the highest speed attainable with those dimensions, would necessitate the cutting-down of her engines, and consequently a reduction of her speed. To put guns in her, would be to reduce her powers of speed further. To rig her and place in her a liberal supply of provisions, &c., would be to diminish her speed still more; and so on. Thus we see that the conditions essential to speed are incompatible with the existence of every other quality, which necessitates the carriage of weight over and above that of the machinery. It should be observed that the larger the vessel the greater the speed attainable; in practice, the greatest speed is always attainable with ships of the largest size, the enormous weight they carry in other ways notwithstanding. Still, there can be no doubt that were the same engine-power given to vessels of smaller size, the speed attainable would be even greater.

Of the proportion between the breadth of the midship section and the length, which we know exercises an enormous influence over the speed, we shall not speak, preferring to confine ourselves to the elements of fighting power, dependent on draught of water, motive power, and thickness of armour.

4. Handiness in manœuvring depends on draught of water and engine-power. The greater the draught of water in a vessel of given dimensions, the larger will be the circle she describes in turning, and the longer she will be in passing over it; on the other hand, the higher the speed the shorter will be the time required for the same purpose, and the more readily will the vessel answer her helm. Thus, the qualities which facilitate manœuvring, are those that favour an increase of speed. Although relatively to the draught

Broad Arrow. of water, they are reciprocally incompatible, so that it is impossible to unite maximum speed with the highest degree of turning power; still, if other circumstances do not interfere therewith, a very high degree of each of these qualities may be combined in one and the same vessel.

5. The excellence of a vessel as a ram or torpedo-ship depends directly on her speed and turning power, so that whatever is unfavourable to these qualities will militate against her efficiency in the performance of the special duties aforesaid.

All the most recent tactical authorities recognise ramming and torpedo warfare as at least equal in importance to artillery fire. This appears to have led to the practice of giving a spur to armour-clad vessels without exception, although, in the majority of cases, these vessels do not possess the special qualities necessary for the effective employment of this weapon. It cannot be otherwise, as the objects aimed at in designing them have invariably been limited to gun-power, thickness of armour-plating, ocean-going qualities, and the possession of auxiliary sail-power. The spur, generally speaking, is added as something of quite secondary importance, so that the ram-power of the vessel is sacrificed for the sake of other considerations, not one iota of which is suffered to be abated. Nevertheless, spurs and torpedoes will, beyond all doubt, become powerful, indeed, well-nigh irresistible weapons, when the vessels carrying them possess the requisite speed and turning power in combination.

6. The existence of masts and rigging implies an increase in the draught of water, so that they exert a direct and injurious influence over the speed and handiness of the vessel carrying them. Besides, in rapid changes of position, they render the vessel less obedient to her helm, as they check her speed in going against the wind. Lastly, masts and rigging diminish the invulnerability of a vessel, because, as before observed, falling portions may easily foul the screw in action, and so deprive the vessel of her powers of locomotion, and render her incapable of continuing the combat.

7. Sea-going qualities in combination with fighting powers are only attainable by largely increasing the dimensions of a vessel, so that to have good sea-going qualities in a vessel of given size, we must be content to sacrifice a portion of her fighting capabilities.

8. The professional skill possessed by the commander and crew is, no doubt, one of the most important elements of fighting power in any vessel. The art of handling a ship can never be brought to absolute perfection; it must always be more or less relative in degree. Independently of personal capacity and profound technical knowledge,

superiority in this respect will depend very greatly on the individual faculty of concentrating the attention upon any one particular object. *Broad Arrow.*

Let us suppose the case of two commanders of equal capacity, placed in similar circumstances. One devotes his attention exclusively, either to ramming his opponent, or to attacking him with his torpedoes; the other brings his guns into play as well. The advantage on the side of the former will be incomparably greater; that is to say, he will commit fewer errors, because his attention will be less divided. We may express the same conclusion in other words by saying, 'The handling of a vessel under given circumstances will be more perfect in proportion as it is more special in its objects.'

This rapid review of the several elements of fighting power shows clearly what was already evident to every seaman—that to combine fighting qualities of all descriptions in one and the same vessel is a practical impossibility. Still, the desire to do so remains, and the results are seen in the monster constructions to be found in the fleet of the present day. All these—their vast cost and unprecedentedly large dimensions notwithstanding—cannot unite all the essentials of fighting power, seeing that each one of these qualities is only really formidable when possessed in a supreme degree.

Gun power will have reached its maximum only when it can penetrate any thickness of armour-plating, and continues so to do throughout an engagement. Armour-plating is only of service when it efficiently protects the vessel carrying it. Speed is only advantageous when it enables us to attack an opponent suddenly, or to show him our heels, or for ramming and torpedo warfare. Turning power is only really useful in enabling us to avoid the onsets of the enemy's rams. The spur will only prove truly efficacious when the vessels carrying it have the speed and turning power requisite to give full effect to a weapon of this description.

All these considerations indicate the necessity of combining certain special and predetermined qualities in individual vessels, so as to secure *maximum* of effect; they show, too, that it is as impossible to institute a comparison between the tactical values of ships of different types as it would be to draw a parallel between those of a regiment of infantry and a battery of artillery. Each has its fullest tactical value under certain conditions, and in all other conditions will be comparatively useless.

Now let us return to our starting point, and endeavour, in as few words as possible, to formulate the results of the foregoing considerations. The attempts we have made to solve the various questions

Broad Arrow.

which have arisen have led us, without exception, to conclusions affecting some or other particular type of vessel; they show, therefore, the necessity for a careful classification of these types. This classification should be based on tactical considerations, in which case alone will it be possible to determine from a tactical point of view the *rôle* most fitted for each individual vessel. They have led us also to the conclusion that the satisfactory accomplishment of tactical ends requires the employment of vessels of special types constructed *ad hoc*; and that the vessels, in which attempts have been made to combine a variety of fighting qualities, will answer very imperfectly to the sanguine hopes entertained of them.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION III.

ARMOUR.

ARMOUR PROTECTION NECESSARY.

ENGLISH AUTHORITIES.

Committee on Designs.

From the Report of the Admiralty Committee on Designs, 1872.

No first-class sea-going ship of war, of manageable size, can be made to carry complete armour protection of anything like 24 inches in thickness, nor do we feel confident that even this thickness, if attained, would permanently continue impenetrable.

Still, in an action between an ironclad and an unarmoured ship, the former has an immense advantage in being able to penetrate the sides of her adversary, at a distance at which she is herself impenetrable, and in being able to use with effect common shells, which fall harmless from her own sides.

After making allowance for the disadvantages of armour, the time has not yet come to throw off armour altogether. The first ranks of our ships of war should continue to carry armour of as great resisting power as possible.

NAVAL OFFICERS.

Earl of Lauderdale.

Earl of Lauderdale. — United Service Institution, March 24, 1878. Discussion on 'Hotspur'-'Glatton' experiment.

With regard to the question whether armour that will not keep out shot is worse than no armour at all, I think any officer that had to choose between an unarmoured ship and one with the 'Warrior's' armour would say, 'I will take the 4½ inches, for that is better than nothing. I will never, if I can help it, let them have a fair shot at me. If I have the heels of my enemy I will keep my bow on;' and 4½-inch armour will keep out a shot from an 18-ton gun, unless it is a fair hit, and any gentleman who has been at sea will know that it is rather difficult to get a fair hit.

Sir Alexander Milne.

Unarmoured vessels should, if possible, have their boilers defended by 4-inch iron to keep out 64 P. shells, although it will largely destroy their sailing qualities.

Sir Alexander Milne.

Letter, April 10, 1876.

Captain Sherard Osborn, R.N.

Captain Sherard Osborn, R.N., C.B.

Letter to the *Times*, November 7, 1872.

SIR,—I was in hopes that some abler pen than mine would have taken up the subject dealt with so well in your interesting articles and treated it from a naval point of view, but, rather than let a verdict against armour-clad ships pass unchallenged, I hope you will allow me to say my say.

Your correspondent on the 30th ult. sums up, that in his opinion it would be 'far less dangerous to fight on an open deck, behind a thin grape-proof bulwark, than in the "Hercules,"' and that as the power of the guns is on the increase, and it may be said that no ships can now carry impregnable armour, such armour had better 'be abandoned as a merely costly encumbrance.' To both these conclusions I demur. In the first place, in a purely fighting sense, the 'Hercules,' which I have had the honour to command, is as much of an imposition as any other ironclad on the broadside principle. The only value from that point of view of such fighting machines is the fact that nearly every European Power, including the unhappy Turks, who are preparing for another Sinope, have spent millions in producing vessels of the broadside sailing type of ironclads, and in dealing with them the 'Hercules,' 'Sultan,' 'Bellerophon,' and others would probably fight victoriously. But, Heaven help the Navy which puts forth to sea and assails us with guns only sheltered by grapeshot-proof bulwarks, if met by our Channel fleet of broadside ironclads.

What sailors ever asked for or expected an impregnable man-of-war? All they ever sought, who ever thought of or knew of the subject, was for the largest amount of protection which could be given against shells penetrating their sides in an entire state, and then exploding between decks or in their batteries. Your informant speaks of 11 and 10-inch guns at Tegel, in August last, sending 'shell after shell through 10 and 12-inch plates and 18 inches of timber backing.' If he means that the shells went through such a bulwark intact, and burst within it, I can only say, if the foreign guns have done this they can do more than I or the Ordnance Select

Captain Sherard Osborn, R.N., C.B.

Committee ever saw an English gun do, and Woolwich had better look to its laurels as well as Elswick. But I think he is mistaken; the solid hardened point of a shell may have got through, but the thin walls of the rear of the shell must have yielded to the enormous strain, and the explosion and langrage probably, as with our shells, blew out to the rear, and the splinters seen within were the *débris* of materials struck by the solid head on its passage. Who ever saw or even knew of any fortification perfectly impregnable to attack? Why should we expect it on the high seas, for an ironclad is only a fortification afloat? With the immense superiority it possesses of power of motion, and selection of position, whether for attack or defence, I have always held, and still retain, the opinion, that the armour where applied should be used to protect the guns and gunners in the first place, and then, so far as possible, spread equally over the rest of the ship or fortification. What is the use of placing it along a vanishing point called the water-line of a man-of-war at sea? Who can find it in a sea-way? Who knows where it is in an Atlantic breeze and an Atlantic sea? And, above all, who could point at it with a rifled gun? No; men in battle will point and fire at the battery they are engaging and suffering from, and if shot can only penetrate that battery, the hardest fighters and toughest nerve must win, and the head of a shell is only an ugly-shaped shot after all. Our naval history attests what a quantity of solid shot a well-fought man-of-war will receive and yet carry off a victory; and if, after all, the day should come when shell can penetrate and explode within heavy armoured batteries, we must face the difficulty, and what is sauce for the goose will be sauce for the gander. I therefore deprecate going back to wooden superstructures or thin iron ones either for real fighting ships, and look with confidence to the 'Devastation' and 'Fury' types, with such further modifications and improvements as experience may develope, as the true type of the future fighting ship either for line of battle or destroying the fortified ports within which an enemy may be preparing to assail us.

There is another point which should never be lost sight of when advocates of the gun talk loudly of the facility with which they can penetrate certain thicknesses of armour: they ignore entirely the deflective power of ship's armour. It is one thing to fire at a plate shut up vertically on shore in front of a gun; it is quite another thing when firing at armour in motion or inclined at any angle to the line of flight of these new pointed projectiles. The old attempt to penetrate the 'Royal Sovereign' turret was repeated with no better success with a heavier gun against the 'Glatton' very recently,

and I know of another curious illustration on board the 'Monarch' of the ease with which her 600-pound shot from a 25-ton gun was deflected. One day at exercise, the captain of the turret fired by accident one of these huge projectiles along her deck in a line which would have swept away Captain Murray Aynsley, her master, and eight men who happened to be in its line, and they were saved by a small bar of iron about two inches in diameter which the shot touched on its shoulder, and that bar, though broken or bent, deflected that huge shot over the ship's side. There will be a large percentage of such deflections in a ship's action, and despite Shoeburyness or Tegel, I deny that in practice it will be so easy to penetrate our armour-plating in the Navy as landsmen and soldiers suppose. *Captain Sherard Osborn, R.N., C.B.*

Yours faithfully,

SHERARD OSBORN, Captain.

Rear-Admiral G. Prebble, U.S.N.

The 'Chesapeake' had nearly twice as many killed, and a total of nearly as many wounded, as had Farragut, in the passage of the forts below New Orleans, in 1862. On the 'Chesapeake' 61 were killed or died of their wounds, and 85 otherwise wounded. In Farragut's fleet, 35 were killed and 135 wounded. In these two ships, in the brief space of fifteen minutes, 252, or about one-third of their united complements, were killed or wounded. In the general engagement of the British fleet off Cape St. Vincent, the whole loss was 296, and in the more recent battle of Navarino, only 286, distributed among twelve vessels, three of which were ships of the line.

Rear-Admiral G. Prebble, U.S.N.

The 'Chesapeake,' *United Service*, vol. i., October 1879, No. 4.

Sir Spencer Robinson.

The Essayist takes away the whole of the armour from the guns and from the men. Now, as has been said at the beginning of this discussion, the whole object of an ironclad is to contend on equal, or even on better, terms with another ironclad. If nobody in the world had ever built an ironclad, I do not know that we should have done so; but what we did feel was, that as long as anybody else had got such a weapon, imperfect as it was, full of faults as it was, still such a weapon was so powerful, that a similar weapon must be provided to contend against it on, at any rate, not unequal terms. We ask no more. We do not ask, because it is not possible, to go about in

Sir Spencer Robinson.

United Service Institution, March 27, 1876. Discussion on Naval Prize Essay.

Sir Spencer Robinson. impenetrable ships, free from all hurt to ourselves while dealing destruction around us; but we ask that we shall not be caught at a disadvantage, that we shall have a ship as good as anybody has, and then we, under Providence, will answer for ourselves. But here the Essayist, in order to procure this very imperfect protection at the water-line, takes away the whole protection from the men and from the guns. I ask you for one moment to consider what the effect of a broadside of the 'Sultan's' 10-inch guns would be upon that war ship which he has described, a ship which will carry, I admit, one-third more guns than the 'Hercules' does, because the 'Hercules'' battery is limited to the protection we can afford to give it by armour, and the battery of the new ship is entirely unprotected, and, therefore, might oppose fifteen guns to the 'Hercules'' ten. But what would be the result at 1,200 yards of shot from the 10-inch guns of the 'Hercules' striking against the battery of a ship built, as the Essayist proposes, of thin iron? Has any gentleman ever seen a target representing the unarmoured side of an iron ship, and noticed the effect of the shell striking that target? If he has, he will say with me, that the ravage it commits is fearful to look at. And then, as there is no limitation, no concentration of the armament of such a ship, but as the guns are spread pretty nearly from one end of the ship to the other, the aim of the opposing gunner will be very much easier; he has a much larger object to fire at; he is not bound exactly to fire at the centre of the protected part of the ship. To do any damage to the protected battery, the fire must be directed to that spot where the space is limited and the execution uncertain; but against the unprotected battery he has only to hit the ship somewhere above the water-line, and he kills men by scores, sweeps the decks, destroys the guns, and ruins the structure.

Captain Colomb.

Captain Colomb.

'Hotspur'-'Glatton' Discussion, March 26, 1878.

In the discussion on the 'Hotspur'-'Glatton' experiment, Captain Colomb adhered to the views he had put forward in his examination of the battle of Lissa.

'I have always looked at it in this way—that the value of armour is simply this—"*to compel your adversary to fire so many fewer shots at you in any given time,*" and I am satisfied that every inch of armour you put on the ship effects that purpose. You compel him to carry heavier guns, and by compelling him to carry heavier guns,

you compel him to fire fewer shots per minnte, and therefore I look upon even a small amount of armour as a very valuable thing. *Captain Colomb.*

. . . .

'It has been rather put to us to-night that there is a possibility, and Admiral Touchard seems to express it very strongly, that an unarmoured ship, with very great gun-power, might successfully meet in the open sea an armoured ship. Mr. Barnaby assumes, I observe, that it is almost necessary that a ship, when she is heavily armoured, should have a few effective guns. She will have few effective guns as against a ship heavily armoured; but it does not follow that she will have few effective guns as against a ship which is not armoured at all. The battle of Lissa was referred to by Sir John Hay, and there we had a lesson. The "Kaiser," the two-decker, an unarmoured ship, which did as good service as she could in that battle, was out of the action very early in the proceedings, and her loss in killed and wounded was two-thirds of the whole loss of the Austrian fleet. I think that is a fact which settles the question completely. Here was a ship such as Admiral Touchard would wish for, I suppose, with a large number of guns. She was set on fire in two or three places. She lost her masts, was thrown out of action altogether, and became quite a burden to the fleet; and she lost two-thirds of the whole loss of the Austrians.'

'Perhaps this is the place to refer to another lesson from Lissa on the question of unplated ships with heavy guns *versus* armour plates. I have seen it several times in print, and I have heard it often seriously argued by naval officers, that the battle of Lissa showed the value of wooden ships against ironclads; and the "Kaiser" has been on such occasions quoted as having beaten off a combined attack of four of them. Granting she did this, what but her evident weakness invited such an attack? and what was the ultimate result of all her gallant endeavours? She was so near destruction that she was obliged to haul out of action. She lost her bowsprit, foremast, and funnel, had 22 men killed and 83 wounded; more than two-thirds, as I before said, of the loss suffered by the whole Austrian fleet. In return for this damage, she tore away the boats, bulwarks, and portlids of the "Rè di Portugallo" by collision, and riddled the upper works of the "Affondatore" by shot; when we have said this, we have perhaps said all. I cannot, therefore, see how we are to place anything whatever to the credit of wood *versus* iron plates in consequence of what occurred at the battle of Lissa. It is argued on this question that we may, by reducing armour-plating, replace **From a paper, 'Lessons from Lissa,' read by Captain Colomb before the Royal United Service Institution, April 29, 1867.**

Captain Colomb.

the weight so taken away by adding to the number of plate-piercing guns. But I think it is forgotten that for every plate-piercing gun carried by the non-plated ships, the plated one may carry several light shell-guns of terribly destructive powers when opposed to unplated scantling only. As an extreme case we should then have a totally unclad ship, whether of wood or iron, carrying a few plate-piercing guns, against a completely clad ship, armed with a multitude of light shell-guns, such, for instance, as the Armstrong 40-pounder. The power of the respective ships when in opposition would then be the number of rounds fired per minute multiplied by the effective work done by a single shot. As the number of light guns carried would be at least five or six times the number of plate-piercers, whilst the rapidity of fire would be possibly doubled, the question to be decided by those who argue in favour of non-plating would be: Can you secure that each plate-piercing projectile shall do ten times the damage on the plated side of its opponent that such opponent's shell will effect on the non-plated side?'

Naval Architects.

Sir Edward J. Reed, K.C.B.

Sir E. J. Reed, K.C.B.

Our Iron-clad Ships. Introduction, pp. xiv. xv.

I consider that Sir William Fairbairn and Sir William Armstrong have been premature (to say the least) in their advocacy—if I have not misunderstood them, of the abandonment of armour for the future. This result may ultimately be brought about, but all the time this country can maintain, with a moderate annual expenditure, the superiority of strength afloat which it now undoubtedly possesses, and which it has gained mainly by the use of armour of increasing strength in combination with improved guns, I am persuaded it will not turn away from so satisfactory a path, and trust all its armaments and all its seamen to structures which can give them no security from even a single shot or shell. For, it should be clearly understood, that the notion of producing fast steamships (which must of necessity be ships with large proportionate boilers and engines) *subdivided throughout* into very numerous small compartments, is a chimera, and has not the smallest foundation in fact or practice. We do well, no doubt, to build fleet unarmoured ships for some of the purposes of the Navy; but to urge that our flag should be trusted to these alone, in the present stage of our progress, is, in my judgment, to press a perilous policy. The abandonment of armour is advocated

upon the ground that it is incapable of resisting the heavy projectiles that can now be fired from naval guns, and is therefore of no more value than the personal armour of the soldier, which was thrown aside when the penetrating power of gunpowder was brought into play. I deny both the assumption and the analogy. I maintain that even the armour which we have now afloat is impenetrable by existing naval guns under the ordinary conditions of sea service; I further maintain that the armour which is now afloat has by no means attained, or even approached, the thickness and weight which it is perfectly practicable to carry on good sea-going ships of not immoderate dimensions; and I deny that, even if all this were otherwise, there would be any analogy whatever between the armour of a soldier and the armour of a ship. I base this last-named position upon the fact that there is this broad and all-important distinction between the armour of the soldier and the armour of the ship, viz., that while the soldier's armour is absolutely and unalterably limited to the weight which a man can carry, there is no analogous limit to the weight which a ship can carry. You cannot increase the physical strength of men, but you can increase indefinitely the carrying and steaming power of the ship, and consequently the cause which long ago determined the abandonment of armour in the Army is entirely without existence in reference to the armour of the Navy. While gunmakers and others therefore indulge in the complacent belief that armour is in vain and that the gun is all in all, I am obliged to maintain a wholly opposite position, and I assert with confidence that just as the 'Hercules' is at this moment impregnable in the region of the water-line to the attack of any and every gun afloat in any part of the world, so the ships of the future may in like manner be endowed with a like impregnability against the guns of the future; and my conviction is that before armour ceases to be superseded as a defence against guns, guns will themselves be superseded as a means of attack, and the ship itself, viewed as a steam projectile —possessing all the force of the most powerful shot, combined with the power of striking in various directions—will be deemed the most formidable weapon of attack that man's ingenuity has devised. But at present neither guns nor armour will be abandoned, and our clear duty for some time to come will be to avoid alike false analogies and speculative forecasts, and to develop as steadily and as rapidly as heretofore the power both of the gun with which we assail the enemy, and of the armour with which we repel his assaults upon us.

Sir E. J. Reed, K.C.B.

Mr. Barnaby.

Mr. Barnaby, C.B. — Director of Naval Construction to Controller. March 1878. Appendix to report of 'Inflexible' Committee.

We do not see that any increase in the penetrating power of guns can make it desirable to dispense with hull armour. It will always remain impenetrable to many guns at all ranges.

The limit to its thickness is to be found, we think, in the size and cost of the ship. Fourteen inches of armour have been found to be consistent with high speed, perfect turning power, and moderate draught of water.

FRENCH AUTHORITIES.

Admiral Paris.

Admiral Paris. — *L'Art Naval,* Paris, 1867, p. 124.

In experimental firing the projectiles are fired with accurate aim, while in actual warfare they are as likely as not to be lost in the air or the water. Moreover, the armoured ship is very far from being defended completely. A large surface has no armour protection; and where the armour is retained its thickness is in many cases sensibly diminished. A small increase in the angle of inclination may completely expose the ship and allow the fatal bolt to penetrate the vital parts—engines, magazines, and especially boilers. And yet, notwithstanding all these imperfections, it is necessary to carry armour; for the guns which can penetrate the armoured would much more quickly destroy the unarmoured vessel.

Admiral Bourgois.

Admiral Bourgois. — 'Etudes sur les Manœuvres des Combats sur Mer.' *Revue Maritime,* 1876, vol. xlix., pp. 825–6.

Avant d'accepter le rôle des vaincus et des faibles et de se résigner à défendre ses ports et ses rades par des surprises et des attaques nocturnes, la marine française a un rôle plus viril et plus efficace à jouer en haute mer. Elle doit y chercher son ennemi et le combattre en plein jour pour le détruire ou le forcer à se réfugier dans ses propres ports. Mais, pour accomplir cette œuvre, il lui faut des navires de combat munis de tous les perfectionnements et de toutes les armes que les progrès de l'industrie et de l'art naval peuvent fournir aux marines rivales. Le prix élevé que coûtent

aujourd'hui ces navires n'est qu'une raison de plus de ne rien négliger de ce qui doit augmenter leur efficacité. *Admiral Bourgois.*

Quant aux chances de succès que peut offrir l'attaque ouverte d'un grand cuirassé par des navires spéciaux armés de torpilles Whitehead, on doit les considérer comme à peu près nulles quand le navire attaqué est maître de sa manœuvre et libre de s'éloigner de l'assaillant en le tenant sous le feu de son artillerie. On a vu, en effet, en examinant ce cas, que la torpille Whitehead est impuissante contre un navire qui prend chasse avec toute sa vitesse, et que le bâtiment qui en est armé, s'il est dépourvu de puissance défensive, est inévitablement condamné à être coulé par l'adversaire qu'il chasse, avant d'avoir pu l'atteindre.

Il en serait autrement si le grand cuirassé, engagé dans une passe que l'escadre à laquelle il appartient veut forcer et par suite obligé de continuer sa route, se voyait assailli par plusieurs embarcations ou bâtiments armés de ces torpilles. C'est à cette circonstance et à quelques autres cas aussi rares de surprises de nuit qu'il faut restreindre l'utilité et l'efficacité des navires spéciaux et des embarcations dont il s'agit. Vouloir l'étendre aux combats du large, ce serait chercher à faire renaître la légende de la baïonnette dans la marine, après qu'une cruelle expérience en a désabusé l'armée. Le bon sens indique que l'invulnérabilité est une qualité d'autant plus précieuse que les combattants se servent d'armes de plus courte portée. Vouloir aujourd'hui combattre sans cuirasse, avec des armes dont l'efficacité n'est réelle qu'à quelques centaines de mètres, ce serait commettre un contre-sens de même nature que si autrefois on avait retiré l'armure aux gens d'armes pour la donner aux mousquetaires.

Si donc il y avait lieu de créer un type spécial de bâtiment de combat pour l'armer de torpilles Whitehead, la suppression de sa cuirasse serait la dernière à accepter et il serait beaucoup plus logique de conserver celle-ci en supprimant l'artillerie ordinaire, qui pourrait être remplacée par l'artillerie sous-marine. On obtiendrait ainsi cette pondération des qualités offensives et défensives, sans laquelle un type de bâtiment cesse de répondre aux besoins généraux de la guerre et trouve rarement un utile emploi.

M. Marchal.

Without pretending to pronounce an opinion concerning the question of abandoning armour protection which has suddenly arisen *M. Marchal.*

M. Marchal. — *Navires de Guerre*, 1876, pp. 118, 119.

in later years and has given rise to so much controversy, we would endeavour to clear the ground by defining accurately the word *décuirassement*, which, from different points of view, has been interpreted in widely different senses. To abandon armour, *Décuirasser*, means, in the sense in which the term is sometimes accepted, to diminish the area of the protected surface with the view to increase the efficiency of the protection. It means, to take a single illustration, to suppress the protection of the guns by side armour according to the plan adopted in the 'Shannon' and the 'Nelson.' It is to be observed that this suppression of a portion of armour, whatever be the part of the ship from which it is removed, whether it be the battery or the water-line, has followed as a natural consequence the movement, which began immediately after the 'Gloire' was launched by M. Dupuy de Lôme. From the 'Solférino' downwards, naval architects have steadily pursued the plan, which at that early date commended itself to the approval of the naval profession, and they have been constantly removing armour from the upper works of ships of war. The abandonment of armour, or *décuirassement*, if we may understand by that term the diminution of the area protected, may therefore be said to be coeval with the introduction of armour.

Sometimes a wider interpretation is given to the word *décuirassement*, and it is predicted that the natural course of the transformation, which is actually in progress, will lead at an early date to the entire suppression of armour. If this were true, the weight of the armour should show an indefinite tendency to diminution. The surface protected being reduced to nothing, and the same weight of armour being retained, the result would be, in the latest armoured ships, that the thickness of the plates would be increased indefinitely.

The same remark may be made with reference to the opinion of those who look to the abandonment of armour as a means of diminishing the displacement of ships. The displacement of a ship depends upon the weight to be carried. Supposing, for example, a ship is thought to be excessively protected and it is proposed to modify the design, confining the alterations to the defensive qualities. In this case the displacement can only be reduced by apportioning a diminished weight to the armour. This may be accomplished in various ways. The armoured surface may be reduced while preserving the original thickness of the armour: and this in fact is what was done in the 'Nelson' type, as compared with the 'Sultan' and the 'Hercules.' It will have been apparent from these observations, that the meaning attached to the word *décuirassement* has relation

both to the reduction in the surface protected, and to a diminution in the weight of armour. The first of these changes is undoubtedly in progress, but it does not constitute a new fact, inasmuch as it dates from the first introduction of armoured ships. With regard to the second, it is certain that it has not in a general sense developed itself in the most recent constructions. In the ships which are represented as having been deprived of armour, the protected surface has been reduced, in order to increase both the thickness and the weight of the armour. Nay, more, improvements in construction have been introduced, with the special object of appropriating to the armour an additional proportion of the total displacement. *M. Marchal.*

On the 'Gloire' and on the 'Warrior' the weight of the armour was about 0·150 of the displacement. In subsequent constructions, this proportion has been constantly increasing. In the later armoured ships, the figure has almost doubled. It is 0·318 on the 'Inflexible,' the least armoured ship in existence, and 0·326 on the 'Foudroyant,' which has a battery with a breadth nearly equal to its length, the guns on the upper deck, as well as a part of the water-line, having no protection by vertical armour. If the *décuirassement* continues to follow its present direction, and a sentence of death is not abruptly passed on the system of armour protection, we have no reason to doubt that our battle ships may be as fully protected as are even now a certain number of our present coast-service ships, and that half of the displacement will be devoted to armour.

L'Année Maritime.

The experiments carried on at our schools of gunnery and in sheltered roadsteads, under uniform and predetermined conditions, however well devised they may be, cannot give a correct idea of the results which may be anticipated at sea. In a matter so complicated, all the elements which it is endeavoured to combine, frequently operate as more or less conflicting forces, yet each exercising a certain influence in deciding the event. The state of the wind, of the weather, and the sea, the more or less advantageous position which may have been taken up in the attack on the enemy, the skill, the coolness, the courage of the captains, the training and the valour of the crews, in short all the circumstances must be taken into consideration. It is clear therefore that experiments on land, or in an enclosed range attached to a gunnery establishment, can at best have but a partial value. *L'Année Maritime, 1878, pp. 167-71.*

In modern times the naval architects have not had the advantage

L'Année Maritime.

of the practical lessons which might have been learnt from the experience to be acquired in an engagement at sea.

In the Army, officers can go to work on fixed principles, because their theoretical rules have been tested by the light of experience. During the last twenty years they have watched a continuous succession of campaigns The wars in the Crimea and in Italy, the campaigns of Prussia, and the war of 1870–71, have dispelled many illusions, and have furnished the means of correcting many mistakes. It has been quite otherwise with the Navy, which, since the radical changes in its material, has scarcely had any opportunity of verifying the calculations of naval architects, and the fitness of their constructions for the services for which they have been designed. Hence, it has been little more than a scientific struggle, a sort of industrial warfare between the naval architect and the gunmaker, a struggle in which the gun has asserted itself with a degree of superiority which has perhaps unduly impressed the minds of men and deterred them from pursuing their investigations. Who can tell whether this exaggerated impression of the power of the gun may not have deterred naval architects from entering on a new field of investigation, in which they might perhaps have found powerful means of maintaining the struggle under favourable conditions. Doubtless, nothing can be more disastrous than the penetration by a projectile of the vital parts of a ship; but, after all, how many projectiles hit the mark? How many strike at an oblique angle, or penetrate parts of the ship that are not vital? In the field of battle, if the bullet pierces the heart of the soldier he is instantly laid low; but, happily, every bullet is not a messenger of death. Though wounded, the infantry soldier may long continue the struggle, and may perhaps deal a mortal blow at the adversary. It is the same with the ship. The gun is not always an irresistible and infallible instrument, which the offensive power of the ship is quite unable to resist. The ram is also a terrible adversary. The projectiles of an enemy strike the armoured bows at an oblique angle, and will therefore fail to stop the ram in its headlong and deadly charge.

In the armoured ship, attention has been concentrated on the penetrability of armour, while too little thought has been bestowed on the offensive power which it possesses, and which it is the business of the tactician to develop. The ship has been regarded rather as a passive target, penetrated by artillery fire, and incapable of offering any resistance. There has been a too general tendency to forget that the ship carries an armament as well as armour, and that the equality of the chances, as between the attack and the

defence, are thereby re-established. Instead of comparing the ship, as a whole, with all its offensive and defensive weapons, its guns, ram, and armour, with another ship, equipped with the same elements of fighting strength, the struggle has been reduced to a sort of single combat, a duel, as it were, between the gun and the armour. *L'Année Maritime.*

Great attention has been paid to questions of construction, to metallurgy, and little to military science. In truth, there have been no essential changes in the naval problem. The changes may have been considerable in certain conditions of the problem, such as the nature of the guns, and through the introduction of armour the relative positions may have been somewhat altered; but the gun retains its decisive superiority as a naval weapon. The offensive has, indeed, always had the advantage over the defensive. Was it not the same with the old wooden ships? Have not the stone of the slinger, the arrow of the archer, the ball of the musketeer, the shot and the shell of the artilleryman, always combined more chances of success in favour of the attack than the thick skin of the savage, the shield, the coat of mail, or the most elaborate fortifications have been able to secure in favour of the defence? Are not the means of attack, after all, the essential instruments of victory?

There has therefore been no change in the first principles of naval warfare. Complete protection is an impossibility; and the limitation of armour to the protection of the vital parts of the ship remains the only solution which is recommended to us by the inexorable logic of facts.

AMERICAN AUTHORITIES.

'*Army and Navy Journal.*'

Army and Navy Journal.

New York, November 29, 1879. Lessons from the engagement between the 'Huascar' and Chilian ships.

The first point to note is the high value of speed in any open-sea action between the war ships of the future. Whether the object in view be pursuit or escape, this element cannot be ignored. The 'Huascar' probably had from the first a hopeless task, yet had she possessed the speed of her consort, the 'Union,' she would have had, like her, the one and only chance of success. She could have tried to run the gauntlet of the Chilian guns, trusting to her heels, and, perhaps, have drawn out of the hopeless fight.

We see also the extraordinary value, in connection with ram-power, of facility of manœuvre. So far as can be judged from the accounts,

Army and Navy Journal.

Admiral Grau did the best possible thing in conducting the combat. He sought to ram the 'Lord Cochrane,' which first engaged him, and had the 'Huascar' touched the 'Cochrane,' the crash would have been fatal. But the Chilian vessel, which had lately been refitted at Valparaiso, was in excellent working order, and had the advantage of twin screws, that enabled her to change her direction within her own length; and when the 'Huascar' came down at full speed, she could only sweep harmlessly by the more agile 'Cochrane's' stern, receiving her fire as she went past.

So far as the comparison of working guns in turret and broadside ironclads is concerned, certainly the former have a good record in this fight. For, during the first hour or more, while the 'Cochrane' and the 'Huascar' were alone engaged, the latter, though having but two 300-pounders, delivered twenty-five shots to the thirty shots received from her antagonist's six 300-pounders—her guns being served, therefore, it seems, more rapidly than her antagonist's. During this time, too, it must be remembered, the 'Huascar' was the prey of a terrible slaughter among both officers and men, owing to the thinness of her armour, while the 'Cochrane' was comparatively uninjured. When the 'Blanco Encalada' came up, the fate of the 'Huascar,' hardly before doubtful, was, of course, sealed.

So far as armour is concerned, the problem of this combat is a simple one. The 'Blanco Encalada' and the 'Cochrane' had nine inches of armour on eight or ten inches of teak; the 'Huascar,' a maximum of four and a half inches. The guns on both sides were rifled 300-pounders—for the small pieces may be left out of the question unless as to the harm done to rigging. The twelve 300-pounders of the Chilians could pierce the armour of the 'Huascar' at the range employed; the two 300-pounders of the Peruvians could not pierce the armour of their antagonists. We think it clear that where the armour was not sufficient to keep out the Chilian shots altogether, the case was almost worse than if there had been no armour. The clean-cut hole through the wood could possibly have been plugged, where the wrenched and torn iron plate could not; but above all the havoc caused by the splinters in shots crushing through the armour was terrible, as the shattering to pieces of Admiral Grau and others shows.

It would seem, also, that the mitrailleuses in the tops of all the vessels were served effectively, causing no little loss of life. The fact that the 'Huascar' was at an early hour rendered useless by the battering of her rudder and steering gear is also one worthy of discussion.

OPINIONS AGAINST ARMOUR PROTECTION.

Sir William Armstrong.

When a solid shot passes through an armour-plated target, it carries with it a quantity of material composing the target, and the thicker the target the greater is the quantity displaced. If the shot break in passing through, as it generally does when made of chilled iron, the fragments of the shot mix with the broken material of the target, and the combined mass is dashed into the space behind. A thin plate of iron, without backing, does not break the shot, and supplies the least quantity of fragmentary matter. Its penetration, therefore, by a shot would be attended by the minimum of destructive effect in a ship, while the maximum would be produced by the penetration of the greatest combined thickness of armour and backing which the shot could freely pierce. Hence it is evident that, unless impenetrability be *insured* by increase of thickness, the only result of the increase is to augment the destructive effect attending penetration.

Sir William Armstrong. — Letter to Earl Dufferin, Chairman of the Admiralty Committee on Designs, 1872.

Next, as to *Shells*. When a percussion shell passes through a thin plate, it travels from 10 to 15 feet before it explodes, and, as its velocity is but little reduced by the resistance of the plate, and as the velocity of dispersion is greatly inferior to that of progression, the fragments form a cone which attains but little divergence in the small space which remains to be traversed before reaching the opposite side of the ship, where, in general, the crew would not be stationed. I conclude, therefore, that more damage would be done by the large mass of fragments driven into the ship by a solid shot passing through a thick armoured side, than by the fragments of the largest shell exploding by its passage through the thin iron side of an unarmoured ship. Not only would the quantity of broken material scattered in the ship be greater in the former case, but it would take effect on the fighting side of the ship, instead of the opposite side, where little harm could be done.

Sir William Armstrong.

Common shells, containing large bursting charges, are, of course, harmless against ironclads. In fact, a plate of *about an inch in thickness* seems generally sufficient to break them; and, when they break, the charge explodes without violence, like loose powder. Much, therefore, may be done in mitigating the effects of these formidable projectiles by the use of plates of very moderate thickness, entering into the construction of the ship. I have already referred to the probably over-rated effect produced by the fragments of such shells bursting inside of an unarmoured ship; but it is also necessary to consider the suffocating action of smoke from the shell, and the demoralisation of the crew by the crash of the explosion.

Size of vessel must follow increased thickness of armour in very rapid proportion, or armament and speed must be reduced. The foregoing considerations as to the present effects and probable future of guns, projectiles, and torpedoes, lead me to the conclusion that no practicable thickness of armour can be expected to secure invulnerability for any considerable length of time. At present, it is *only the most recent of our armour-clads that have any pretence to be considered invulnerable.* All the earlier vessels, when built, had just as much claim to be so regarded as the strongest ships of the present day; yet they are now completely left behind, and are, in my opinion, much inferior to well-constructed unarmoured ships. I venture to ask: What reason have we to suppose that the powers of attack will not continue quickly to overtake the increased powers of resistance, which we are applying at great increase of cost, and at great sacrifice of general efficiency? Every addition to the weight carried for defence must be attended with a diminution of armament and of speed, unless the size of the ship be increased in a very rapid proportion. A continual addition, therefore, to the thickness of the armour, involves either a continual reduction of offensive power, or such an increase in the size of the vessel, and its consequent cost, as must limit the production of sea-going ships of war to a number inadequate for constituting an efficient Navy.

Vertical side armour should be almost wholly abandoned, and watertight compartments substituted. In my opinion, armour should be wholly abandoned for the defence of the guns, and, except to a very limited extent, I doubt the expediency of using it even for the security of the ship. Where armour can be applied for *deflecting* projectiles, as at the bow of a ship, it would afford great protection without requiring to be very heavy; but in other cases, where it must be of great thickness to be effective, I think its advantage is not adequate to the sacrifice it involves. *Watertight compartments*

would alone be available against torpedoes, and *it appears to me they would also afford the best security against the effect of penetration by projectiles at or below the water-line. If we were relieved from the deadweight of heavy armour, the gain of flotation would afford the means of enormously increasing the armament and the speed of the vessel. Or, what would be better still, we should be enabled to reduce the size, and increase the number of our ships, so that the loss of a single vessel should no longer be a national calamity, as at present.* We could then have comparatively *small* sea-going ships, *with abundance of* speed, and *heavy armed;* and, happen what may, such vessels could never be out of date, for they would always be well adapted for protection of commerce, for colonial service, and for the attack of flotillas carrying an invading force. It would be necessary to adhere to iron as the material of construction, and the plates composing the skin would require to be considerably thicker than those used in ordinary shipbuilding, to prevent penetration by grape-shot or steel projectiles from Gatling guns. The armament of these vessels might include one or two guns, capable of piercing the heaviest armour, and the rest should be light, but wide in the bore, so as to throw large shells with moderate velocities. A mixture of guns on the Gatling principle would also be of great service against boat attacks, and for pouring streams of bullets through the portholes of an opposing ship. A vessel so constructed and armed would be a formidable antagonist for an ironclad, even in a duel of artillery, while for ramming, or for using torpedoes, her superior speed and handiness would give her great advantage over a heavily encumbered adversary. But we could afford to use these vessels in far greater numbers than ironclads; and, whatever the result of a single combat might be, a combined attack of several such vessels upon one iron-plated ship would, in my judgment, be wholly irresistible. I hope, therefore, I may be excused for expressing an opinion that *swift vessels of iron, divided into numerous compartments, with boilers and machinery below the water-level, and only very partially armoured,* constitute the class of sea-going ships which it would be most prudent to build under the present prospect of the progress of artillery, and the science of attack.

Sir William Armstrong.

Mr. Stuart Rendel, M.P.

In May 1872, the *Engineer* published a valuable sheet showing the penetrative power of our heavy muzzle-loading guns, and the ranges at which those guns might be expected to pierce the different

Mr. Stuart Rendel, M.P. Memorandum 1874.

Mr. Stuart Rendel.

Memorandum on the gunnery question, 1874.

ironclads in our service. In July 1873 the War Office prepared a chart of a similar character, but more complete and authoritative in form. No one can look at this chart without being struck with the evidence it gives of the abortiveness of past efforts to secure the impenetrability of ships, or without feeling that the costly struggle between guns and armour might probably have been abridged in the past and should surely be shortened in future.

From the first it has been argued with great force that the protection of vessels by armour could only prove a passing condition of naval warfare, and that, like body armour, ship armour would disappear, when once freely penetrable, as being worse than useless.

From the first it has been pointed out that the offensive power of the gun could be more readily and extensively developed than the defensive power of the armour. For it is weight alone that limits the development of both guns and armour afloat, and, power for power, the weight of encircling armour increases far more rapidly than the weight of encircled gun. The pity is that with this foreknowledge the struggle between guns and armour should have been spun out in a long-drawn series of small steps and countersteps, when a few bold strides might have put an end to it, and saved time, money, and material.

By the War Office chart it is shown that the naval service gun of 25 tons weight (a gun by no means exceptional) penetrates at 500 yards the breastwork of the 'Devastation' and the water-line of the 'Peter the Great,' the most heavily plated ship afloat (afloat in dock, but even yet, April 1875, incomplete). The same gun penetrates the belt of ironclads of the 'Hercules' class at 1,200 yards, the turret of the 'Cyclops' class at 2,800 yards, and turret of the 'Monarch' class at 3,800 yards. A gun of half the weight penetrates the sides of the 'Cyclops' class and the turret of the 'Monarch' at 600 yards, and the side of the 'Hercules' class at 2,000 yards. A gun of one-fourth the weight penetrates the sides of the 'Hercules' class at 4,000 yards and of the 'Minotaur' class at 1,100 yards. Making, then, ample allowance for differences between results calculated from experiment, and results to be realised in actual war, it is clear that guns of and within 25 tons weight have the complete mastery over the great bulk of modern ironclads.

If the question be put whether the present state of things could not have been foreseen, it might be replied, yes, and for this reason. A rifled wrought iron coil-built 600-pounder gun of 23 tons weight was completed by Sir William Armstrong, so long ago as March 1863, and tested at Shoeburyness in the same year.

That gun, surnamed 'Big Will,' after destroying a 'Warrior' target at 2,000 yards by mere ricochet, and smashing an 11-inch solid plate, fired over 200 rounds, and is still in the service. It seems clear then that, so far as the guns are concerned, the mastery which the 25-ton sea service gun at present displays over existing ironclads might have been more or less demonstrated by this 600-pounder gun produced no less than twelve years ago, had the Admiralty determined to float it. Such mastery once shown, it may be assumed that the ironclads, begun and completed within these eleven years, and already in so great a measure obsolete, would have been built, if built at all, on very different principles. *Mr. Stuart Rendel.*

Much of course may be said in defence of the slowness and tentativeness of the progress made with the mounting of heavy guns afloat. It may perhaps be declared that our best policy was not to do our utmost in gunnery, but to be content with a bare superiority over foreign naval ordnance, not to mount guns of unnecessarily surpassing power and not to embark in great artillery experiments afloat. Yet the truest policy is generally the natural, direct, and thoroughgoing policy of taking the fullest advantage of the highest attainments of science. The solution of the monster naval gun question would at least have given us a clearer insight into, and opened a more direct and rapid way towards the solution of the ironclad ship question. To-day it is no longer doubted by the authorities in this or other countries that guns of even 100 tons weight can be, and will be mounted at sea, and this single fact goes far to upset the whole of our past labours in ironclad ships.

It is not difficult to conceive causes that may have contributed to direct the actual course of events.

The designing, and, to a large extent the manufacture, of ships of war rests with the Admiralty, while the designing and manufacture of naval guns rests wholly with the War Office. The Admiralty may naturally incline to rank the ship before the gun, and, since they have the choice of weapons, but no personal interest in or connection with the production of the weapons, they may prefer such guns as suit their designs and not such as would embarrass them. Though they watch, and in a large degree provide for the advance of artillery, they are tempted to be slow in recognising that advance, and to do so only as they see their way to meet it by an equivalent advance in the power of resistance of their ships. So long as foreign naval artillery is not ahead of them, they feel no pressing need to give the predominance to the gun at the cost of the ship. In fact the possess the power, and are tempted to use it, of handicapping the

r. Stuart Rendel.

guns by limiting their weight in the contest with ships, and it is handicapping in fact which has done most towards maintaining the struggle. Meanwhile the War Office may be supposed to fix the power of coast guns, in reference to the power of guns and ships actually afloat, and thus the action of the Admiralty may determine indirectly to a great extent that of the War Office in regard to the choice and growth of guns.

Hence it may be that it happened that in 1863, although the 600-pounder was an accomplished fact and a fact of first-rate significance, the Navy was still of opinion that 6½ tons was the limit of the weight of a broadside gun, and 12 tons the maximum weight for a turret gun. It seems reasonable to suspect that, had the Admiralty been the manufacturers of their own ordnance, or had they obtained their ships' designs from outside their office, they would have insisted upon much heavier guns being carried afloat in 1863 than were then actually carried, still more that, had both the Admiralty and the War Office been equally free of any connection with manufacture of either ships or guns, a more equal hand would have ruled, and fuller and freer play been given to each side in the contest between guns and plated ships.

At this moment, March 1874, the Admiralty is undoubtedly taking a handsome course towards gunnery. Though they have only one 35-ton gun armament afloat, they have given the gunmakers *carte blanche* and have agreed to mount guns of 85 tons weight and 27 feet long. To accomplish this object they sacrifice in part the armoured protection of the guns, and thus take the first step towards the abandonment of armour.

This then looks like the beginning of the end of armour. At the first the whole of the exposed parts of a vessel were armoured, next the armour was confined to the water-line, the battery, and the engines. Now it is proposed to secure flotation and locomotive power; soon flotation will be the only consideration, and then comes the end of armour.

On the other hand, the advance from the 35-ton guns of the 'Devastation' to the 85-ton guns of the 'Inflexible' is accompanied by no compromise or abandonment of principle, and appears to present no unusual difficulties.

Doubtless the adoption of such guns involves the complete and thorough instead of the incomplete and partial application of mechanical power of working them. But this is a gain to gunners; because the combination of manual and mechanical power gives all

the disadvantages of both systems, and the full advantage of neither. Once mechanical power exclusively is applied and accepted, the advance of gunnery beyond the 85-ton gun would seem to offer less difficulty than the present rise from 35 tons to 85 tons. *Mr. Stuart Rendel.*

Assuredly such advance will be made neither to gratify English artillerists, nor to confound English naval architects, but, if for no other reason, at least to meet foreign competition.

Many no doubt will see with regret so rapid a development of artillery as would not only render our finest ironclads in a sense obsolete, but also make more painfully evident the insufficient gun accommodation of our new and costly coast fortress. Yet it must be a very hazardous policy to restrain wilfully the natural advance of artillery science out of consideration for existing interests. Captivating as the present contest between ironclads and guns may be to some, and deservedly profitable as it is to the reputation of others, the time seems to be come when we should push through it as rapidly and boldly as possible, and challenge the artillerist to perform what he is so ready to undertake, and to produce ordnance capable of putting a speedy end to the struggle between guns and armour afloat.

There are some obvious disadvantages to this country in the continuance of the ironclad phase of naval warfare. Ironclads are so slow of production that during their reign we lose the benefit in sharp and short modern wars of our extraordinary powers of production. The difficulty of giving them the maximum speed and coal capacity within reasonable draught and dimension unfits them for protecting our prodigious and ubiquitous mercantile marine. Their extraordinary cost prevents us from multiplying them in numbers sufficient to cover the enormous area of our possessions. The necessity for their existence in various special types each of limited utility, and in combination with unarmoured ships, tends to complicate and to dissipate our naval resources.

Once we have established the penetrability of possible ironclads, and have mounted an adequate number of competent guns afloat, their use will assuredly decline and may probably cease, and with them that perhaps of monster guns also.

In such an event British sailors will be glad to find general offensive power, speed, handiness and staying power once more the primary conditions to be attained in ships of war, to which may be subordinated the question of protection with all its uncongenial accompaniments.

[illegible] of the [illegible] and the prospects of artillery and [illegible] in the same direction, and, without at [illegible] abandonment of armour, [illegible] our Navy may be urged as the sure [illegible] contests by which the [illegible] prolonged.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION IV.

TURRET SHIPS AND MONITORS.

ENGLISH AUTHORITIES.

ADMIRALTY COMMITTEE ON TURRET SHIPS.

Copy of the Report of the Admiralty Committee on Turret Ships.

ADMIRALTY ORDER FOR ASSEMBLING THE COMMITTEE.

Admiralty, 27 April, 1865.

Rear-Admiral Yelverton, Captain Caldwell, Captain J. J. Kennedy, Captain H. B. Phillimore. Secretary, Mr. Arthur Price.

MY LORD,—The Lords Commissioners of the Admiralty having appointed you Chairman of a Committee of naval officers selected to examine the design of a sea-going turret-ship submitted to their Lordships by Captain Coles, I am to signify their direction to you to assemble, as soon as convenient, at the Admiralty, the members of the committee named in the margin.

You are then to inquire carefully into the following points:—

1. Armament.
2. Protection of the ship by armour-plating.
3. You will consider the arrangements of the machinery, boilers, up-take, and funnel with reference to their safety from damage by the shot from an enemy's vessel.
4. You will carefully examine the arrangements for manœuvring and steering the ship in action, and the amount of protection afforded to officers and men engaged on that duty.
5. You will consider what sea-going qualities the vessel may be expected to possess, particularly with reference to the following points:—

Speed.
Steerage, including power of turning quickly.
Easiness in a sea-way.
Dryness.
Power of carrying sail.
Rolling.

Pitching. *Admiralty Committee.*

Power of fighting her guns in a sea-way.

Stowage of boats, spars, &c.

Stowage of anchors, and facilities for working them and the cables.

Riding at anchor.

Arrangement of masts and amount of sail.

The advantages or disadvantages of the proposed rig in action, and at other times, and the facilities for clearing for action.

The security of the masts under fire.

6. You will consider the arrangement for the accommodation of the officers and men, for their health and comfort, and for their protection from weather and sea both when cleared for action and under ordinary circumstances, also for ventilation, and generally any other points affecting the health and comfort of the crew, as well as the stowage of provisions, water, and stores.

I am, &c.,

C. PAGET.

Vice-Admiral the Right Hon. Earl of Lauderdale,
17 Upper Hyde Park Gardens.

REPORT.

To the Right Honourable Lord C. E. Paget, Secretary of the Admiralty.

MY LORD,—In pursuance of the directions of the Lords Commissioners of the Admiralty, signified to Vice-Admiral the Earl of Lauderdale, by your letter of the 27th of April, 1865, appointing us a committee to examine the design of a sea-going turret-ship submitted to their Lordships by Captain Coles, we have the honour to report that we assembled at the Admiralty on the 2nd of May, since which time we have been continuously engaged in the consideration of the various points of enquiry to which our attention was directed by their Lordships.

4. We now proceed to give the result of our deliberations.

I. *The revolving turret system of armament as applied to a sea-going ship.* Advantages of turret system.

ADVANTAGES.—5. The distinctive advantages of this mode of armament appear to us to be:—

(*a*) That it is the most efficient mode of carrying and working very heavy guns in a sea-way.

A steadier platform is obtained from which to fire.

Admiralty Committee. A gun mounted in a turret is higher out of the water, and being also in the centre of the ship, can therefore be fought longer and more efficiently in a sea-way than when mounted on the broadside.

The extent to which the gun can be trained in a turret is only limited by the obstructions on the deck. There is also greater facility of training than with broadside guns as at present fitted.

When under the fire of musketry, the port in the turret can be turned away from the enemy while the gun is being loaded.

More elevation can be given to the guns on the turret system than on the broadside, as ports are now fitted.

So far as being able to keep the gun when loaded always pointed towards the object, a greater rapidity of fire is obtained by the turret system, the captain of the turret having at all times a distinct view of his object, which in a sea-way would be frequently lost sight of by the captain of a broadside gun; and further, the object is less liable to be intercepted by smoke.

(*b*) There is better protection for the men fighting the gun who are actually inside the armour-plated part of the turret, and also for the gun and carriage, in the turret system than in the broadside.

(*c*) We believe that a turret with 6-inch armour plating would be almost invulnerable as regards penetration against any guns of less weight than 12 tons.

(*d*) A ship armed with two turrets has the advantage of being able to direct all her guns on the same object on more bearings than by any other known plan; and of throwing a heavier weight of metal on either broadside than can be done by any armour-plated vessel of equal size and tonnage armed in any other mode now afloat, or that has yet been designed, so far as we are aware of.

(*e*) Of two vessels of the same speed, one armed on the broadside, and the other armed with two turrets, the latter has a greater facility of placing herself to an advantage in action, by keeping head to sea in a sea-way than the broadside ship.

(*f*) If the ship were totally dismasted and the screw disabled, a one-turret ship would probably, and a two-turret ship certainly, be able to continue the action to greater advantage than a ship armed on any other plan under the like circumstances.

(*g*) When a ship has to go through an intricate channel, or up a winding river, where the enemy is always in range, the turret system would give a greater facility to a one-turret ship probably, and a two-turret ship certainly, of keeping her guns bearing on the enemy, while the ship would be following the course of the channel or stream.

6. **Disadvantages.** Against these advantages must be set the disadvantages that such a system of armament would entail upon a sea-going ship, and which appear to be as follows:— *Admiralty Committee.* *Disadvantages of turret system.*

(*a*) The liability of the turret to be disabled or temporarily impeded in its working, under any of the following circumstances:—

The possibility of a steel shot or shell entering the top of the turret when the vessel might be rolling towards her enemy, or exposed to plunging fire from a battery.

The probability of a shot or shell from a 12-ton gun penetrating the turret, or entering through the armour plating of the ship's side, disabling the guns, or damaging the turning machinery of the turret.

A heavy shot striking the ship's side abreast of the turret, even without penetrating, would be liable by the great concussion to send fragments of wood or iron into the lower part of the turret or its machinery, and temporarily prevent its working.

If a turret-ship were heeling towards the enemy, a shot passing through the upper deck, between the glacis plate of the turret and the ship's side, would damage or disable the turning machinery.

The probability of the men stationed within the turret, who might be leaning against its side, being seriously injured by the concussion in such a confined space, if the turret were struck by a heavy shot without penetrating. Evidence, 906.

(*b*) The possibility of the ship being boarded and the turret jammed by wedges.

(*c*) The great length of deck fired over when firing forward or aft with any depression, especially when using very heavy rifled shot with the largest charges, which it is supposed might injure the deck or fittings. Evidence, 895.

(*d*) The difficulty of securing hatches or openings in the deck which would be in the way of the line of fire of very heavy guns.

(*e*) If, from any circumstances, it should be necessary to manœuvre the ship under sail, in action, or to employ men on deck for any work or duty, the total want of protection for the men employed on deck, and the impossibility of their remaining on that part of the deck near which the guns are being fired; as also the risk of their being washed overboard, if the ship should be driven against a head sea when cleared for action.

(*f*) The difficulty (without sacrificing the advantage in the turret system obtainable by extreme lowness of the ship in the water) of constructing a sea-going ship armed on the turret system, so as to have her upper deck of sufficient height above the water to render

Admiralty Committee. the ship a good sea boat, and afford adequate protection for the health and comfort of the crew under all circumstances, but more especially when forcing the ship against a head sea, trade wind, monsoon, or strong periodical winds met with in all parts of the world, and which ships are liable to encounter when making a passage.

(*g*) The necessity for having so many fittings on deck, as well as the bulwarks, moveable; and it being questionable whether the bulwarks can be made sufficiently strong to resist the sea; and the liability of moveable bulwarks to be washed away, or get out of order from constant wear.

(*h*) The being obliged to unstow and ease down the anchors, to unship and let down bulwarks, besides removing everything moveable from the line of fire, and seeing the deck clear of men, and the hatches secured, before going into action, would cause considerable delay.

(*i*) If the captain of the turret has not better protection from rifle fire than is at present afforded him in the 'Royal Sovereign,' he would be the most exposed person in the ship, which might render him unsteady in action.

Advantages of turret system for coast defence vessels fully admitted.

7. Opinion on Turret System. We fully recognise the great advantages of the revolving turret system of armament as applied to floating batteries, and harbour and coast-defence ships, to which they are in a great measure confined; as vessels on the 'Monitor' plan can be built so low as to render it most difficult to hit them, and in which the unlimited training of the turrets would not be interfered with by masts or other obstructions. A floating battery of this description, even with one turret only, would be most formidable, for, if the turret were disabled, she could haul out of action under protection of her consorts.

Advantages of system materially curtailed in a sea-going ship.

8. But in a sea-going cruising ship these great advantages would be materially curtailed, because all sea-going ships of equal speed and tonnage and carrying the same weights must be of the same height out of the water to enable them to possess the same good sea-going qualities, and to be equally dry; and must necessarily have masts and other fittings, which would materially limit the amount of training of the guns.

Consideration given to the system by foreign Powers. Evidence, 784, 806.

9. We have heard that ships built on the 'Monitor' system could cross the Atlantic with comparative safety, but such vessels cannot, in our opinion, be ever looked upon as sea-going cruising ships. It is shown in evidence that the French, who, there is little doubt, have carefully weighed the question of arming ships with

revolving turrets, have not adopted the system, nor even thought it desirable to give it a trial, in a sea-going ship. Again, it would appear that the Americans, who have had considerable experience with turret-ships of various descriptions, both in and out of action, do not consider them desirable as sea-going ships.

Admiralty Committee.

10. Notwithstanding these statements, weighing the advantages and disadvantages of the turret principle, and the very divided opinions on the subject entertained by naval architects and naval officers who have given careful attention to the question as it regards sea-going ships, we consider it most desirable that a conclusive trial should be given to the system in a sea going ship to be armed with *two* turrets, capable of carrying two 12-ton guns in each turret, or, if necessary, one 22-ton gun in each; as we think it very possible that such guns as those of 22 tons may be required at sea ere long, and it is not improbable that the French, when considering the subject some time ago, did not contemplate the necessity of carrying such heavy guns.

The system should have a trial in a sea-going ship. Evidence, 1,005. (*Report of Special Committee on Iron Plates*, 1864, p. 16.)

11. We are inclined to the opinion that, for sea-going ships, the system should be limited to *two* turrets; for there are many disadvantages if more than two are placed in a ship; and one turret only we think most objectionable. If more guns than those in the two turrets be considered desirable, the space between the turrets could be profitably turned to account in a ship of sufficient displacement, by connecting the turrets with a battery of guns worked on the central-pivot system.

The system should be limited to two turrets in sea-going ships. Evidence, 1,227.

The evidence given to the Admiralty Committee by Sir Spencer Robinson formed the subject of an article in *Fraser's Magazine*, from which the subjoined extract is borrowed.

Paper on the British Navy, March 1871.

It was in 1865, or in 1867, or in 1869, that the superiority of guns to armour-plating of 5 or 6 inches was established; but in 1865, before the Naval Committee upon Turret-ships, and in 1867, in the competition of private shipbuilders, the late Controller and Chief Constructor of the Navy displayed a partisanship of opposition to turret-ironclads which is now most deeply to be deplored. Mr. Childers came into office, as he tells us in his recent Minute, without any prejudices on the subject, but determined to give fair play to the advocates of either type of shipbuilding. He had opposed in the House of Commons, on the 13th of July, 1868, a motion censuring the

Fraser's Magazine.

Paper on the British Navy. March 1871.

Fraser's Magazine.

Conservative Board of Admiralty for not having built more ships of the turret type. He suggested to Mr. Reed the building of a turret-ship of 3,000 tons with limited sail power. Mr. Reed produced in preference designs for a class of powerful unmasted ships, carrying on the sides solid 12-inch, and on the turrets solid 14-inch armour, with a freeboard of 4½ feet, and a plated breastwork rising 7 feet higher out of the deck, and enclosing the turrets, funnels, ventilators, and hatchways of the ship. A ship of this class had been already designed for the Russian Navy, but, with that exception, the design was a novelty; and accordingly, before deciding on its adoption, an Admiralty Committee, consisting of Admiral Lord Lauderdale, Rear-Admiral Yelverton, Captain Cowper Coles, Mr. (now Sir) W. Fairbairn, Mr. (now Sir) Joseph Whitworth, and Dr. Woolley, were appointed to criticise the design, and advise the Board upon it. The design was approved, and the ships ordered in accordance with it are the 'Thunderer' and 'Devastation,' two of our first class of turret ironclads. The importance of the subject and the admirable clearness of the exposition will justify us in quoting at some length from the statement made to the Committee on that occasion by Sir Spencer Robinson:—

'The Controller of the Navy showed, by reference to the thickness of armour-plating carried by our ships compared with the power to pierce such plates possessed by the artillery known to be afloat, *not only in our own ships, but also in the ships of other Powers*, that the time had come when even 8-inch armour-plating was an insufficient protection; and, adverting to the increasing power of artillery, which, though slow, was an element not to be neglected, explained that the great feature of the new design was so to protect the water-line and armament of the ship as to resist practically, and for some time to come, the artillery that could be brought against such a ship at sea. He pointed out the slow progress that had been made in obtaining the so-called 600-pounder, which in reality is a 12-inch 25-ton rifled gun. It had taken upwards of four years to bring us even to our present position with reference to this gun, and even now it was hardly satisfactory; and admitting that it was possible that the process of constructing even larger guns might in future years be accelerated, he stated that the new designs were calculated practically to resist projectiles from guns even of 27 or 28 tons.

'For this purpose the thickness of armour-plating adopted was 12 inches on the hull, *and 14 inches to defend the armament.*

'He then showed, by reference to the enormous weights which such a system of defence rendered necessary, that the armour-plating must be limited as much as possible, to economise the size

Fraser's Magazine.

and therefore the cost of the ship; deducing from these premises the conclusion that *a ship of low freeboard was an absolute necessity, and that, this necessity existing, a broadside armament was impossible*; so that the design naturally resolved itself into a 'Monitor' type, and a turret armament.

'He stated that the proposed armament was to be two 25-ton guns in each turret, that the ship was to carry two turrets, that there was to be an absolute and uncompromised line of fire from these guns on every point of the horizon.

'He explained that the ships were specially designed as powerful sea-going ships; not so much as cruisers for the ordinary protection of commerce, as engines of offence, capable of being sent to the Baltic or Mediterranean, across the Atlantic, to the West Indies, or to the Cape of Good Hope. In adverting to the lowness of the freeboard (4 ft. 6 in. at the load-line of the new ship), he showed that such lowness was not incompatible with safety, and was extremely favourable to steadiness. He instanced the remarkable cases of the "Monadnock" and the "Miantonomah," ships of this type, one of which had gone into the Pacific; the other had twice crossed the Atlantic. The freeboard of this ship at her mean draught was only 2 ft. 7 in. amidships; and while the ships in her company of the ordinary construction were rolling as much as 20 deg., the "Miantonomah" was barely rolling 4 deg. He further explained that this lowness of freeboard, while it contributed powerfully to a steady platform for artillery, had of course the effect of allowing large masses of water to pass over the deck; and in ships like the "Miantonomah," where the portholes of the turret were but from 2 to 3 feet above the deck, they were necessarily closed in an even moderate seaway, and thus the ship was in a great measure deprived of her artillery. As a remedy for this defect, and to protect the base of the turrets, an armour-plated breastwork, 7 ft. 6 in. high, surrounds the space occupied by the turrets. This breastwork, the upper part of which is 11 ft. 6 in. above the water, is closed in by a deck plated with iron 1½ inches thick, through which are carried up the hatchways, funnels, air-tubes, &c., and over which the guns command an uninterrupted range on every point of the horizon, at a height of upwards of 13 feet from the water, insuring the use of the offensive powers of the ship under almost every possible circumstance.

'Dispensing with masts made a very large supply of coal necessary; and accordingly the design provides for 1,700 tons of fuel—a quantity sufficient to enable the ship to steam for 10 days at 12 knots' speed, or for 18 days at 10 knots, or from 25 to 35 days at lower speeds.

Fraser's Magazine.

'The security given to a ship by her masts and sails compared with that obtained by two propellers and double engines was referred to, and *it was stated as a fact perfectly well known to all naval officers, that, in going into action, the first order which must be given is to send everything down from aloft*; in fact to deprive a ship as much as possible of the power of using any of her sails; *that, even so prepared, the risk to a ship having her masts shot away is great, and that if they were shot away it is all but certain that the ship would be deprived of her steam-power, through the wreck either fouling or destroying the screw.*

'This view of the case was illustrated by the history of several remarkable wrecks—those, for example, of the "Prince" and the "Royal Charter" amongst others—which occurred from the loss of masts destroying the propeller, which up to the time of that occurrence was taking care of the ship.

'There was, on the other hand, no known instance of any iron-clad ship, or indeed of any screw ship with a damaged engine, on a lee shore, deriving her safety from the use of her sails; and in considering the benefit to be derived from sails in steadying a ship of the ordinary type in the trough of the sea, it was pointed out that the amount of canvas required for this purpose in a ship of about 9,000 tons displacement, would necessitate a system of masting entirely inconsistent with low freeboard and with the proper use of the turret-armament.

'The necessity of doing nothing to compromise the all-round fire and the end-on fighting qualities of the ship was insisted on, and the sacrifice of those qualities which would follow any system of masting pointed out.

'It was shown that the new designs somewhat resembled in type the "Miantonomah" and the "Monadnock," while they differ widely and fundamentally from the "Captain" and "Monarch." It seemed therefore certain that a far more correct forecast of the qualities of the new ships, especially of their steadiness in a sea-way, would be formed by making use of the experience already acquired in these American Monitors than could follow from any variety of trials of the "Captain" and "Monarch." Indeed, on reviewing the turret-ships of the Royal Navy, it was evident that no such ship had that real lowness of freeboard which would enable any trials or experiments to be of use for purposes of comparison.'

REPORTS FROM CHANNEL FLEET.

Admiral Warden.

On Wednesday, the 26th September, the signal was made, 'Can you fight your weather guns?' and, as the 'Lord Clyde' was the only ship which replied shortly, 'No,' I hope I shall stand excused for going somewhat at length into a description of that day's practice.

Admiral Warden. — Extract from report of Channel Fleet. Parliamentary paper, 171, session 1867, pp. 12, 13.

We give the concluding paragraphs of Admiral Warden's report:—

The experience of the practice on the particular day in question leads to the reflection, and to the very important question, 'Could a turret-ship of equal size and power have done better, or have proved herself more efficient in powers of offence and defence?' and I think there are some considerations which would lead to this question being answered in the affirmative. Take the position of this ship first; she would have been utterly unable, as I think I have conclusively shown, to have opened her main-deck ports to fire, unless placed head-on to the sea. Her broadside guns train rather more than two points before and abaft the beam, and they are supported on the upper deck by two guns, one on the quarter deck and one on the forecastle, training respectively about 19 deg. before and abaft the beam. It follows, therefore, that if a turret-ship had taken up a position on either bow or quarter of this ship, there would have been a radius of four or five points on either bow or quarter, which would be points of impunity, or she would at the worst only have to contend with one gun. But further, suppose the turret-ship was obliged to take up a position where the broadside guns of this ship would bear on her when they could be fired, the result would be that the main deck of this ship and the upper deck of the turret would be both flooded alike; but the advantage would, as I think, still remain with the latter. The sea might, and probably would, wash right over the deck of the turret-ship, but the water would be got rid of, whilst here it is not at all clear that it could be got rid of, and certainly not as fast as it would accumulate.

The guns being amidships on the line of the keel, would not be subject to such violent motion, and therefore more easily managed, and make better practice. The gun, if it did get from under all control, could not find its way out of the turret; but if a main-deck gun got adrift on the deck here, it is difficult to say what consequences might not ensue. Moreover, it is not conceivable that the

Admiral Warden.

turret could roll so as to destroy the cartridges in the guns; whereas, in the case of this ship the larger proportion, if not all of them, would be so destroyed.

I am quite aware that the advantages I have named, and several others, have already been clearly and forcibly stated in the Report of the Turret-ship Committee, presided over by the Earl of Lauderdale, dated June 1865; still, in a report of this nature, I should not have felt justified if I had abstained from giving expression to the reflections arising in my own mind from the target practice on the afternoon of the 26th ultimo.

I have, &c.,

F. WARDEN, Rear-Admiral.

Rear-Admiral H. R. YELVERTON, C.B., Commanding in Chief.

Sir Spencer Robinson.

Sir Spencer Robinson.

Remarks on Admiral Yelverton's report on the Cruise of the Channel Fleet, December 1866.

Both the Admirals consider that under circumstances of heavy rolling a turret-ship would have very decided advantages over a broadside ship, and it is easy to show by a diagram that such is the case, because the diagrams can always place the turret-ship in the most favourable position for her qualities. This may not always be so easy to do in actual warfare; but, admitting all the Admirals say on the subject, there still arises this consideration: the sea-going turret-ship has shown as much disposition to roll as her broadside consorts. Now, whether her gun is mounted in a turret, or in a port on a ship's side, it is clear that it is only when either vessel is nearly upright on the top of the swell that the gun can be discharged with a prospect of striking the object aimed at. A ship, therefore, rolling from 12 to 15 times in a minute, will be in a position to discharge her artillery 12 to 15 times during each minute; but, if it be taken into consideration that under these circumstances she rolls through areas of from 20 to 30, the shortness of the time during which the gun is horizontal, and can be discharged with any prospect of striking an object, becomes so apparent as to reduce the supposed advantages of the training derived from mounting the gun in a turret very considerably: the oblique fire which the turret-ship is supposed to inflict on her opponent, is also the fire which is the most harmless to an ironclad.

Again, except in the ironclads designed by the Admiralty (designs not approved by the inventor), the nearness of the gun to the water has an important bearing on the probability of striking the object fired at, as the undulations of the sea, even when the ship is

rapidly flying past the vertical position, must often completely interpose between the gun and the object aimed at. *Sir Spencer Robinson.*

The conclusion I should draw from these remarks would not be that there is no advantage whatever in a well-designed turret-ship carrying her guns high out of the water under circumstances of heavy rolling, if she were put into a good position in an encounter with a broadside ship, but that these advantages, in such turret-ships as we are acquainted with, are not altogether so great or so decisive as they might appear at first sight. Conclusion.

Moreover, it seems to me a sound conclusion to draw from these reports, that a naval engagement with ironclads will seldom be attempted unless in a moderate sea.

ROBERT SPENCER ROBINSON.

TRIALS OF THE CHANNEL FLEET, 1868.

Admiral Warden.

Admiral Warden.

Trials of the Channel Fleet in 1868.

Guns of any weight can be placed in turrets, armour of almost any thickness can be carried round them, and it will then only be necessary to protect the water-line with a belt, as heavy and as thick as the ship can bear. These conditions carried out, it remains, of course, that the turret-ship should be constructed so that she should be a habitable and comfortable ship for the officers and men, with a sufficiency of sail power to enable her to meet the varied requirements which are usually made on a British man-of-war.

The question again naturally arises, 'Is it impossible to build such a ship?'

The conditions above stated, which seem to render a resort to turret-ships inevitable, seem also to point out that, in the broadside ship, armour-plating will eventually have to be given up everywhere, except at the water-line and at the bow and stern, to protect guns firing in a line with the keel.

In ships built completely of iron, with guns as heavy as they are capable of carrying, protection must be reduced to a minimum, and shot and shell be allowed to find their way through and through the iron fabric, perhaps with less damage to ship and life than if they had been checked in their progress by armour-plating.

TRIALS OF THE CHANNEL FLEET, 1869.

Commodore Goodenough.

Commodore Goodenough.

Channel Fleet, 1869.

The guns might, as far as motion of the ship went, have been fought without difficulty on any day of the passage, but on many days the wash of the sea was sufficient to fill the guns, to drench the gear and crews, and to keep the main deck afloat fore and aft. All firing under such circumstances becomes wild in the extreme from the gun's crew being completely unsteadied, though not from the ship's own motion. I have no doubt that the ship's great length is rather a cause of this great amount of wash of sea into the ports. With a head or following sea both the ends are constantly unsupported, and the sea then rises high amidships, or *vice versâ*.

[N.B.—Commodore Goodenough was serving in the 'Minotaur.']

Enclosure 3 *in No.* 2. *Reporting on the Behaviour of Her Majesty's Ship 'Monarch' in the Bad Weather of the past Week.*

H.M.S. 'Monarch,' Queenstown, 29 September, 1869.

Captain Commerell, R.N.

SIR,—In obedience to your Memorandum of the 28th instant, I have the honour to report the behaviour of Her Majesty's ship 'Monarch' during the bad weather of the past week.

The ship was at all times everything that could be desired as a sea boat, buoyant, and at the same time remarkably steady. On no occasion did she roll beyond 15 deg., and that quite the exception. She shipped no water whatever, and did not strain a rope-yarn. Her guns were all capable of being fought either to windward or to leeward with the same ease as at Spithead, and I should not have hesitated for one moment, either for action or for exercise, to have cleared the decks, leaving standing the usual shrouds.

In contradistinction to this efficiency, I beg to remark that, in my opinion, if any accident arose in heavy weather to this ship when under sail, it would certainly be only due to the balance rudder. Running before it with no after sail, it was found almost impossible to keep the ship from broaching-to, and I frequently expected that the rudder would have gone altogether, from the strain brought on it.

I have, &c.,

J. E. COMMERELL, Captain.

Vice-Admiral Sir T. M. C. Symonds, K.C.B.,
Commanding in Chief, Channel Squadron.

Admiralty Board Minutes.

With reference to turret-ships, my Lords are convinced that the policy adopted by Parliament, on the recommendation of this Department in the case of the 'Glatton,' and still more markedly in that of the 'Devastation' and 'Thunderer,' should be continued; viz., that a certain number of sea-going turret-ships, intended to proceed, if wanted, to distant stations, but not for cruising, should be constructed without masts, with twin screws propelled by double engines, and having great capacity for fuel. To what extent the spars and rigging of the 'Monarch' and 'Captain' interfere with their efficiency will be better known after the trials about to take place, but that that interference is considerable there is already no doubt. *Admiralty Board Minutes.* On Reports of the Channel and Mediterranean Squadrons, 1869.

NAVY TURRET-SHIPS.

RETURN TO AN ORDER OF THE HONOURABLE THE HOUSE OF COMMONS, DATED JULY 29, 1868;—FOR COPY 'OF OPINIONS OF NAVAL OFFICERS UPON THE MERITS OR OTHERWISE OF THE TURRET-SHIP AS A SEA-GOING SHIP.'

Admiralty, July 29, 1868. JOHN HENRY BIGGS, CHIEF CLERK.

No. 1. *Copy of Letter from Captain Brandreth to several Captains.*

You know that there is going to be a debate in the House about the turret question, on Mr. Samuda's motion to substitute two turret-ships instead of two broadside ships building, without waiting to try the 'Captain' or 'Monarch' at sea. *Captain Brandreth.*

Mr. Corry would like to have all the information he can on the subject, and will be glad if you will write your opinion on the question, with reasons for or against the turret-ship as a sea-going ship.

As it is not a party question, but one of getting the best description of ship for the country, without allowing it to be led away by prejudiced opinion, Mr. Corry would like to refer to your opinion if necessary, but would not do so if you have any objection.

Yours, &c.,

T. BRANDRETH, Captain, R.N.

No. 2. *Captain W. C. Chamberlain to Captain Brandreth.*

Portsmouth, May 20, 1868.

Captain W. C. Chamberlain.

DEAR CAPTAIN BRANDRETH,—I am one of those who for years have been anxious to see a real hearty attempt made to succeed in obtaining a seaworthy turret-ship, because I believe that such success is possible, and that such a vessel would, at least under ordinary circumstances of warfare, be much more formidable than one of similar tonnage on the broadside principle.

I was present on board the 'Bellerophon' the day she fired into the 'Royal Sovereign,' and I was forcibly struck by the fact that frequently the 'Bellerophon' could have got *no gun* to bear upon the 'Royal Sovereign' *anywhere*, whilst there was not a moment, as far as I could see (with the exception of that when the 'Bellerophon' was right ahead or right astern), that the 'Royal Sovereign' could not have brought *all* her guns to bear at choice upon any spot on the 'Bellerophon' which was in sight. It appeared to me then, and the conviction remains on my mind, that the 'Royal Sovereign' is by far the most formidable machine of the two; and I believe that if real goodwill was set to work to produce the best sea-going turret-ships, the result would be such a ship as nothing now floating would dare to encounter.

It is true that much money and many years might be spent before the comfort of broadside ships could be attained, but where there is a will there is a way, and contrivances would, I think, soon crop up to conquer difficulties, and render these novel ships both habitable and healthy.

Thus you will see that I am in favour of proceeding with turret-ships; though it might not at all follow the particular vessels Mr. Samuda alludes to would reach the excellence I believe experience alone will prove to be obtainable.

I may add, that should my anticipations as to the possibility of building 'sea-worthy' turret-ships prove unsound, such vessels could hardly fail to be of great value for coast-defence, and would for that purpose alone be worth constructing without delay.

My opinion is unreservedly at Mr. Corry's disposition.

I am, &c.,

WILLIAM C. CHAMBERLAIN, Captain, R.N.

Captain T. Brandreth, R.N.

No. 3. *Captain Vansittart to Captain Brandreth.*

H.M.S. 'Achilles,' Portland, May 22, 1868.

Captain Vansittart.

Dear Brandreth,—I am an advocate for turrets, and believing that guns will, in the long run, beat armour, would build them capable of carrying heavier metal than we now think of: 12 and 18-ton guns could then be replaced by the monster guns of future days. I would commence turret vessels *forthwith*, and if the earlier ones failed to meet all the requirements of long cruising, foreign stationed sea-going ships, the money would not be wasted, inasmuch as a home force capable of resisting any troublesome naval Power, or all foreign navies together, would give confidence to the Government and people, and enable John Bull to defy all enemies.

Yours, &c.,

E. W. Vansittart.

No. 4. *From Captain Hood, H.M.S. 'Excellent.'*

May 23, 1868.

Captain Hood.

I consider that sea-going ironclad ships should (to be efficient) possess the following qualifications:—

1. Be thoroughly fit to cruise as an ocean squadron, or perform a voyage to any part of the world under sail with but little assistance from their steam-power; have a sufficient height of freeboard, and standing bulwarks sufficiently high and strong to protect the crew from the sea in bad weather; also good accommodation for officers and men, and plenty of room on the upper deck to enable the ropes, sails, &c., to be properly worked, and boats and spare spars stowed.

2. Have a fairly steady platform, or, in other words, should not roll in moderate weather sufficiently to interfere with working the guns or delivering fire with precision; be able to deliver a fire from heavy guns right ahead, right astern, on either bow or quarter, and be ready for action with the least possible delay at all times. I will now, with regard to the above-mentioned qualifications, compare an ironclad ship armed on the broadside principle with a turret-ship.

To enable a ship to be an efficient ocean cruiser, and to proceed to any part of the world under sail without much use of her steam-power, it is evident that she must possess a very considerable amount of sail-power, and consequently large masts and yards; a ship armed on the broadside principle has a large clear upper deck with plenty of room for the crew to work the ropes, sails, &c., and this deck, from

Captain Hood. its height above the water, and strong bulwarks, affords in bad weather good protection from the sea.

A turret-ship proper has a low freeboard, and cannot possibly have strong standing bulwarks, as in action they must always be let down in order to be out of the way of the fire from the turrets. The consequence of this low freeboard is, that even in moderate weather the upper deck would be continually washed over by the sea, and in anything like bad weather it would be impossible for the crew to work the ropes, sails, &c., on this deck; and I believe that a moderately heavy sea would smash the moveable iron bulwarks, thus leaving the upper deck without the slightest protection from the sea, except at the bow and stern; it is therefore absolutely necessary in sea-going turret-ships to construct a spar deck above the turrets, on which the men can work the ropes, sails, &c. This spar deck must necessarily be of less width than the turrets, otherwise it could not stand the concussion of heavy charges fired underneath it, and consequently the space on such a spar deck must be very much less in a turret ship than in a much smaller vessel armed on the broadside; and in my opinion a large clear upper deck on which the crew can work the ropes, &c., in bad weather (well protected from the sea) is a point of the greatest importance in an ocean ironclad ship.

From the great space taken up by the turrets it is necessary to provide extra accommodation for the officers and crew; this is usually done in turret-ships by building a forecastle and poop on the upper deck. The forecastle is also of the greatest assistance in preventing the sea from continually washing over the bows, as it otherwise would when steaming head to wind even in moderate weather, and also in working the anchor gear. Without such a protection it would be almost impossible for men to stand and work forward whilst stowing the anchors in anything like a sea. This addition of a forecastle and poop, although of great use for the reasons I have mentioned, wholly prevents the fire from being delivered either right ahead or astern, and this is a very serious defect, as in the event of a turret-ship chasing or being chased by a vessel armed on the broadside principle, she could not fire at the enemy without yawing.

A ship properly armed on the broadside principle has, in addition to the delivery of a heavy independent or converging fire from her broadside guns, the power of delivering a heavy fire either ahead, astern, or on either bow or quarter. For instance, a ship of the 'Audacious' class will, in addition to her heavy broadside fire from the main deck battery, be able at the same time to fire two 12-ton guns ahead and also two 12-ton guns astern from her upper deck,

which is a most important point in action. Also from the height of these guns on the upper deck out of the water, they would in tolerably close action be able to fire on the unprotected decks of a turret-ship, and also sweep the tops of the turrets with case shot, which in my opinion would have the greatest effect in keeping down the fire. The efficiency of firing from turrets depends wholly on the accuracy of aim taken by the captain of the turret, who whilst aiming is obliged to have his head and shoulders above the top of the turret; he is in a measure protected by an iron projection round the hole through which the head passes; but I have as yet seen no really efficient fitment for protecting him from the fire of riflemen in the tops of an enemy's vessel, still less from the fire of case from the upper deck guns of one of the 'Audacious' class; in fact, if the captain of the turret were thoroughly protected whilst aiming, his range of vision would be very materially curtailed, and the rapidity of aiming consequently diminished, so long as the aiming is carried on by the present plan through the top of the turret. I have a firm opinion that in tolerably close action the fire of case from guns on the upper decks of vessels like the 'Audacious,' and also from riflemen in the tops on the top of the turrets, will have a very great effect in keeping down the fire. *Captain Hood.*

It is probable that a turret-ship will, from her low freeboard and central weights, roll in bad weather considerably less than a ship armed on the broadside, and thus afford a steadier platform for the guns; but this lowness of freeboard and total absence of bulwarks would frequently cause the sea to enter the ports of turrets, and thus impede loading.

For the above-mentioned reasons I am of opinion that, with regard to sea-going ironclads, ships armed properly on the broadside are most decidedly to be preferred to turret-ships; but for coast defence, when the advantages of the turret system can be developed to their fullest extent, by means of low freeboard, no masts, and nothing to interfere with the fire from the turrets in every direction, I consider that turret-ships are by far the most formidable class of vessel.

A. W. A. HOOD, Captain, H.M. Gunnery Ship 'Excellent.'

No. 5. *Captain George Willes to Captain Brandreth.*

May 20, 1868.

MY DEAR BRANDRETH,—I hold very strong opinions about sea-going turret-ships, and I have not the slightest objection to Mr. Corry making use of my name. *Captain Willes.*

Captain Willes.

I think the Admiralty quite right in not substituting 'two turret-ships for the broadside ones in the building programme,' until the 'Captain' and 'Monarch' have been properly tried *at sea.*

Every day proves how unwise it is to embark so largely in any one new scheme. At this moment we see that public opinion forced us to adopt largely the twin screw, which we shall much regret. I object to a sea-going turret, because directly you make one, you lose the great advantage of the system, *i.e.* an all-round fire. I object to any ship being sent to sea with such few guns.

The Dutch turret-ship was here a short time since, when I closely inspected her. To make her habitable a large poop and forecastle was necessary; so that with these decks and tripod masts, really the points of the circle on which the guns would bear are very small.

The Dutch captain, on my raising this objection, answered, 'But with the twin-screws I can point the ship.' This is an entire fallacy, as in the 'Penelope' we have found (she is only 260 feet in length) that the screws will not turn the ship at all (pivotting), except in a light wind, and then very unsteadily.

When the turret system was first started it was considered the only means of working heavy guns, but now we have 12-ton guns on the broadside worked with as much ease as a 32-pounder formerly, and I see no limit to the size of the broadside gun, as there is certainly not to the strength of the ship, nor is there to the number of the guns.

Therefore, in a ship like the 'Lord Warden,' we can have any sized guns, any number of them, a right ahead and a right astern fire, a plunging fire, and a crushing fire.

We are all forgetting the last point: only conceive a broadside of fifteen well-directed 9-inch shot striking a 'Royal Sovereign'!

At the Nile we had Sir James Saumarez's ship firing *one* broadside at a French frigate and sinking her; and finally in the 'Lord Warden' we have a fine, airy, roomy, habitable ship, well ventilated, plenty of light, for we must remember the animal; to maintain a fine race, which Englishmen I hope always will be. The above are necessities, then, in your broadside ship; you are ensured a force which the turret-ships would not have; this is most important on our distant stations.

In the 'Ocean,' in China, we have a body of men to land and protect our people; to man ships, which would be brought out there in case of war.

After having said all this against sea-going turrets, I beg that it may be most distinctly understood that, in my opinion, a turret

vessel proper—the 'Royal Sovereign'—has all the elements necessary for 'harbour and coast defence.' It always struck me that in the panic of 1860 there was at hand the very means of creating an enormous defensive power at *comparatively* small cost. *Captain Willes.*

It is to be hoped that even now the country will see the utter folly of these ridiculous and stupid forts, and spend a part of the money which must be spent in arming them, by converting every sound line-of-battle ship in our ports into 'Royal Sovereigns'; then, when the occasion arises, a few seamen, stokers, and marines embarked on board each would enable us to show a second line of defence which would astonish Europe.

I have not adverted to one of the points raised in the case, 'Turret *v.* Broadside,' that is, the steadiness of the platform, because, as the 'Achilles' rolls less than any other ship, and the 'Bellerophon' is fairly steady, it shows the rolling of 'Lord Warden' and others is due to form or distribution of weights, and has nothing to do with the broadside ship.

Believe me, &c.,

GEORGE WILLES.

Captain Brandreth, R.N.

No. 6. *Captain King Hall to Captain Brandreth.*

The turret system I consider perfect for coast and harbour defence, both for our own shores, colonial and foreign possessions; and the importance of having one or two of moderate size, light draught, and, from the condition of very high speed not being required, comparatively inexpensive turret-ships at each of our mercantile ports, ready to protect the free entrance to the port, and which could be manned readily on the spot, cannot, in my opinion, be overrated. Being able to concentrate in large numbers on any point of attack, they would be a most formidable force. The details for their being manned and maintained might be most simple. *Captain King Hall.*

Low freeboard, and, ordinarily speaking, a steady platform for their guns, from the waters they would usually navigate in, would be obtained. But sea-worthiness, in its comprehensive meaning (namely, for sea-cruising and long voyages), with a low freeboard, which is a steady platform, which is the condition the turret system aims to arrive at, would not be looked for, nor do I think ever has, or can be attained.

I take the liberty of writing frankly to you, because I deem it a public duty, and sincerely trust that no pressure of irresponsible

Captain King Hall.

opinion will tempt the Board of Admiralty to order other sea-going turret-ships to be built until the 'Monarch' and 'Captain' have been fairly and honestly tried, their defects discovered, and improvements suggested.

I consider a sea-going turret-ship should be able to proceed alone with despatch to any part of the world, at any season of the year, fulfilling all the conditions of a ship of war, and among them the comfort and proper accommodation for the crew; and because the 'Miantonomah,' or 'Monadnock,' under convoy, have made sea-passages, and others have gone to various parts of the world, it manifests simply that they are able to make the passage, as the 'Raft' did which crossed the Atlantic last year, or as they report the 'Red White and Blue' did, or the 'Rob Roy Canoe' does every season, without regard to time occupied in the passage, which just makes the difference.

I would also remark that the possibility of a shot or shell going over and bursting in the top of the turret when rolling, appears never to be taken into account; but the assumption that the sides of the turret will always receive the fire. To exemplify my meaning, if you will consider your hat a turret, allow a friend to throw marbles at it, the sides will be struck; but give it a rolling motion of five or six degrees only, and the marbles aimed at the upper part will pitch over the rim, and when this took place the destruction may be readily conceived.

These matters should be decided and dealt with in a practical manner, and what may appear to be perfect in diagram and points of ingenious speculation, should be proved by absolute certainties.

W. King Hall, Captain Superintendent.

Sheerness Dockyard, May 22, 1868.

Captain Cowper Coles.

Captain Cowper Coles.

From a paper, 'The Turret *v.* the Broadside System,' read before the Royal United Service Institution, May 1, 1867.

I will not tire my audience by reading over the names of twenty ships built or building in Europe on my plan, varying from 1,000 up to 4,000 tons, beyond telling you that their aggregate tonnage, leaving out the 'Monarch,' is 16,204 tons, with a weight of broadside of 12,000 lbs., and requiring 1,392 men to man them.

It has been asserted that there is no great economy in turret-ships, but I ask anyone to produce the same amount of broadside tonnage that could compete with these 19 ships. To produce the same power of broadside, viz., 12,000 lbs., as thrown by these turret-

ships, the *broadside* system would require 36,000 tons of shipping, showing an increased expense for their construction of 1,572,782*l.*, besides necessitating a greater consumption of fuel, and a greater number of men, amounting to 3,124 more, costing 238,539*l.* per annum. *Captain Cowper Coles.*

It may be said that it would be impolitic to reduce the number of men we keep up in the Navy, but at all events, *now* that men are becoming yearly more expensive and scarce, it appears to me to be of the greatest importance that we should be able to man *more* ships with *fewer* men. . . .

We find by Admiral Warden's report that the 'Lord Clyde,' with only 6½-ton guns, fired 15 rounds from five guns in 45 minutes, or three rounds at the rate of one round in 15 minutes, whilst head to sea, with a roll which did not 'exceed 10 or 11 degrees.'

The 'Royal Sovereign,' with defective wooden carriages, fired, according to Captain Key's report of November 7, 1865, ten rounds, from her two guns in the foremost double turret at the rate of 2 min. 35 sec. per round, with a maximum roll of from 13 to 15 degrees; and that same day fired 74 rounds with ease at the rate of 2 min. 16 sec. per round, without mishap; and although the sea came upon her deck, not a bucketful of water came into the turret.

Gentlemen, this is a triumph I must be excused for exulting in, and for taking this opportunity of contradicting the erroneous statements made against fighting turret guns.

Admiral Yelverton says:—

'The turret system of arming a ship would have had a great triumph on this occasion, for there is no doubt that a sea-going turret-ship, say 12 or 14 feet out of water, would have fought her guns without the slightest difficulty, and have fired easily six shots to every one from our broadside ships.'

In the discussion which ensued Sir Spencer Robinson said:—

'The idea—to put a gun upon a turntable, and to surround that turntable with armour-plating—embodied in a low level armour-plated vessel like what is now known as the "Monitor vessel," is the most perfect conception to my mind of what you ought to have for attack and defence of ports and arsenals.' *Sir Spencer Robinson.*

Sir Edward Reed, K.C.B.

The real advantage of the turret consists in the fact that while the arc of training of the turret gun may be made very great without *Sir E. J. Reed, K.C.B.*

Sir E. J. Reed, K.C.B.

Our Iron-clad Ships, ch. xi. pp. 225, 226.

any increase in the size of the port, it is impossible to obtain a large arc of training with a broadside gun, or with a gun mounted broadside fashion, without enlarging the port and weakening the ship's side considerably in its immediate neighbourhood. For this reason, and for some others that will follow, I have always looked forward to a large adoption of the turret system in those classes of ships in which masts and sails are not requisite, or in which they can be so subordinated to the turret armament as to leave it in possession of this its prime advantage, viz. a large range of horizontal command.

The next point to which I shall advert is the capability of fighting the same guns on both sides of the ship. There can be no doubt that this is, in the abstract, an advantage, but it is one which is attended with great drawbacks in the turret system. The chief of these is the very large weight of armour in various forms, much of which has to be devoted to the protection of the guns, and which may be roughly taken as double the amount that is requisite on the broadside system, gun for gun. In other words, with a given weight, you can protect and work eight guns, mounted on the broadside, four on each side of the ship, about as effectually as you can protect and work four guns only mounted in two turrets; and, looking to the history as well as to the prospective circumstances of naval warfare, it must of necessity be better to have four guns to fight with on each side simultaneously than to have only four altogether, whatever facility of training the latter may possess. This point has been very much lost sight of by many advocates of the turret system, whose notion no doubt was, and in many cases perhaps still is, that you can carry even more guns on the turret plan than on the broadside plan. The fact is, however, quite otherwise, and would be even more favourable to the broadside system than it is, if the same sacrifice of independent training were made in the case of broadside guns as is made with turret guns, viz. that of fixing two guns side by side, and depriving both of all independent training. For it must be borne in mind that even in the largest turret-ships of our own and other navies—excepting the 'Royal Sovereign,' the 'Prince Albert,' and two or three vessels built in Russia and America—there are but two turrets, and that the two guns in each of these are so connected as to be compelled to train together, whereas every gun in the eight in an equivalent broadside ship has a perfectly independent set of motions. If, on the other hand, we were to mount broadside guns in pairs, it would be quite practicable to shorten the central batteries, and give to the broadside ship an even greater attacking force on each side than the turret-ship has available for both sides. It will be

necessary to bear this aspect of the question in mind when we come to consider more closely the relative merits of turrets and broadside ships in respect of their attacking powers. . . . *Sir E. J. Reed, K.C.B.*

No satisfactorily designed turret-ship with rigging has yet been built, or even laid down. . . .

Nothing can possibly prevent a pure monitor vessel from being deluged by the sea in rough weather, to an extent which is as incompatible with ventilation and comfort as it is with fighting efficiency.

When ordered to employ the monitors on blockading duty outside the bar at Charleston, Admiral Du Pont reported 'that they are totally unfit for the duty, and particularly in the hot season. In even a slight sea the hatches must be battened down, and the effect upon the crew, if continued for a brief period in hot weather, would be most deleterious, indeed in such weather they are not habitable.' The commanding officers in a joint report on the same subject say 'that the hatches would have to be battened down the whole time, and the vessel could not fail to be disabled from loss of health to the crew.' . . . This report also bears testimony to the vulnerability of the low decks. . . . Every shot fired at short range from the central battery of the 'Hercules' would penetrate the 'Monarch's' water-line and boilers, while the water-line and boilers of the 'Hercules' are protected from the 'Monarch's' fire by a deep and impregnable armour-belt. The weakness of the 'Monarch' in this respect is due mainly to the turret system itself, which demands so much armour for the protection of the turrets as to leave comparatively little for the sides of the ship. It is on paper, and in the imaginations of men only, that these miraculous exploits of turret-ships take place; in an actual engagement their omnipotence would be qualified, and the impotence of other ships would be less easily secured.

FRENCH AUTHORITIES.

M. Dupuy de Lôme.

M. Dupuy de Lôme. — Debates, French Chamber of Deputies, 1870.

In the debates in the French Chamber on the Naval Estimates for 1870, M. Dupuy de Lôme said 'the American is essentially a local Navy, constructed to meet the exigencies of the war of the Secession. The monitors are not battle ships for ocean service.'

Admiral Touchard.

Admiral Touchard. — A propos du Combat de Lissa, 1860.

The turret affords facilities for mounting guns of any calibre. It offers the surest and most efficacious means of carrying and working at sea guns of the maximum calibre. The barbette tower, with a turntable, does not afford complete shelter, either to the gun's crew or to the gun, and this disadvantage is aggravated by a heavy roll, or under a plunging fire; but it is much lighter, and by reason of its lightness it makes it possible to preserve a few lighter pieces mounted in an armoured citadel on the broadside.

Encore la Question du Décuirassement, Paris, 1876.

In the exercises of the evolutionary squadron of 1874, two divisions of the squadron, which were supposed to represent two hostile fleets, made repeated charges, the ships passing each other frequently, within a distance of sixty yards; and I am assured, from the reports of the captains, as well as from my own observations, that the guns mounted in turrets fired three shots, while those mounted on the broadside could only fire once at the enemy on the beam. This fact is sufficient to prove the advantage of mounting the artillery in a single line on the longitudinal axis of the ship.

Admiral Baron Grivel.

Admiral Baron Grivel.

In the ninth chapter of *La Guerre Maritime*, Baron Grivel sums up an elaborate comparison of the broadside and turret systems as follows:—

Guerre Maritime. 'Guerre au large,' ix. *Les flottes cuirassées de haut-bord. Considérations nautiques et militaires*, pp. 203, 204.

In the greater number of the circumstances which may be anticipated in war, the turret-ship will have the advantage over the broadside ship for the following most important reasons:—

1. The range of fire of the guns is extended over a wider arc of training, if not over the entire horizon.

2. Superior protection is afforded for the guns and the guns' crews.

3. In many cases the guns are mounted at a much greater height above the water than is possible in a covered broadside.

In considering the comparative efficiency of turret and broadside guns, where ramming is the main object of the tactics adopted, Baron Grivel gives expression to his views as follows:—

'This is the reasoning of one of my friends, Captain Foullioy, who formerly commanded a ship in the armoured squadron. Where it is intended to fight with the ram, the training of the gun should be completely independent of the movements of the helm. Experience and common sense will satisfy us of the correctness of the rule thus laid down. In point of fact, all that the captain of a ram can do is to watch every movement of his enemy without losing sight of him for a moment. He must endeavour to steer by the engine and the rudder in such a way as to strike his adversary on the broadside, or to parry the blow directed at his own ship. An engagement between two rams is like a duel. If the captain allows his attention to be distracted with the effort to use other weapons, he runs the risk of being rammed by his enemy. In handling his ship he must never think of his guns.'

It is only by means of turrets that the ram can be effectively combined with the gun.

M. Dislère.

M. Dislère.

In the turret, the captain of the gun looks out through an opening in the top of the structure, and has before him a clear field of view. The sights, one near the eye and the other near the edge of the

M. Dislère. tower, are about five yards apart, which makes it possible to lay the gun with great accuracy. In the broadside, on the other hand, the captain of the gun is unable to take a long deliberate aim through a narrow port, with a very restricted field of view, and limited line for training the gun on the object. The sights being of necessity scarcely four feet apart, it is difficult to lay the gun with accuracy. It is further to be observed that the broadside gun is laid by the captain of the gun; and having regard to the reduced number of guns in the ironclads of the present day, it would seem that an excessive responsibility is thrown on a petty officer. In the turret, on the other hand, an officer aligns the sights, and gives the necessary orders for training the turret by the steam or the hand-training gear.

La Marine Cuirassée, ch. iii. pp. 57, 58.

. . . .

Ch. iii. p. 62. We have summed up the advantages and objections to the broadside and the turret systems of armament with reference to the contingencies of battle. In our view it is difficult, considering the numberless conditions in which the two systems are almost of equal value, to express a decided preference. We can understand that in some cases it may be decided to adopt the monitor type, and that it will be retained for coast-service; but we must now take into view other conditions, with reference to the suitability of the turret-ship for cruising at sea, and for service as a line-of-battle ship. Here, one by one, all the characteristic advantages of the monitor type disappear, and we are made sensible only of its defects—defects so grave, in our opinion, that it is difficult to accept vessels of this type as ocean-going line-of-battle ships.

. . . .

Ch. iii. p. 74. This renewed investigation has only confirmed the opinion we expressed in the *Revue Maritime*, in 1867, on our return from a mission to the United States. We then said that while the turret-ship was of value for coast-service, whether for attack or defence, it would be completely unfit for admission into our sea-going squadrons.

La Marine à l'Exposition de 1878. Although it may be in many respects very interesting and very successful as regards speed and turning qualities, there is no occasion to examine and estimate in detail the new 'Tonnerre' class, because this coast-defence vessel is, at present, undergoing certain important alterations found necessary in consequence of her trials at sea.

The forms of the upper-works of a vessel intended to keep the sea in all possible weathers—and such is the case with the first-class coast-defence vessels, which should take part in operations on hostile

and distant coasts—cannot be the same as those of monitors or of vessels for the defence of rivers and harbours. Low freeboards and breastworks retired from the broadside, especially when these breastworks do not occupy the great portion of the length, elevated superstructures with a flying deck, whose smallest defect is to be odd in appearance and inconvenient in the matter of accommodation, are not compatible with the fundamental conditions which tradition assigns to, and which it seems right should be fulfilled by, a sea-going ship. These conditions, it is true, were conceived in an especially nautical country, but it should not be forgotten that they were originated with a view to the navigation of rivers and the interior of harbours. *M. Disère.*

Following on the first monitors, properly so called, of North America, built during the War of Secession, England constructed in 1867, for the Government of India and not for the service of the fleet, the 'Cerberus,' intended for the defence of Melbourne, and the 'Magdala,' for that of Bombay. These modest early coast-defence vessels, with their narrow breastwork and very low freeboard, the breastwork enclosing two separate turrets joined by a light superstructure, with a speed of eight knots and 90 tons of coal, without masts, were certainly not sea-going ships; and it was not then thought that they would be reckoned as great fighting-vessels, or squadron cruisers. After a short interval more confidence was felt in the new type.

In the years 1868, 1869, 1870, the period of bold innovations in naval architecture as testified by the building of the 'Captain,' the 'Cyclops' (3,300 tons displacement), 'Glatton' (5,000 tons), English 'Devastation' (9,300 tons), 'Peter the Great' (9,800 tons), and lastly the 'Dreadnought' (11,100 tons), were simultaneously laid down. In some of these vessels at least the breastwork is not narrowed, and the wall of the upper works is continued vertically from fore and aft.

In spite of these numerous and important examples, which have not been initiated in France, as we hasten to remark, we are convinced that this class of special mastless vessels, however powerful they may be as regards their guns, their armour, and their sphere of action, in a word the combination of their fighting qualities, cannot be considered as good squadron ironclads, because, over and above their fighting qualities, they do not possess to a sufficient degree the qualities of sea-worthiness, habitability, nor in some cases that perfect security which are indispensable.

Returning to that which specially concerns coast-defence vessels

M. Didère. properly so called, we consider that the conditions of service on the high seas require, as it has always been admitted without dispute in the past, that the sides of the above-water portion of the hull should be carried up so as to form a volume of buoyancy proportioned to the size of the vessel, if not throughout her length at least through a great part of it. Is it not plain that, before giving protection from an enemy's fire and before facilitating the working of the guns, by an exaggerated reduction or partial suppression of the freeboard, a ship must be made thoroughly able to contend with the winds and waves? This is a contest in which ships are engaged every day. Engagements with an enemy occur at rare intervals.

AMERICAN AUTHORITIES.

NAVAL AND OFFICIAL OPINIONS.

Rear-Admiral Dahlgren.

Rear-Admiral Dahlgren, U.S.N.

From the report of the Secretary of the United States Navy on armoured vessels. Report dated off Charleston, January 28, 1864.

The 'Ironsides' is a fine powerful ship. Her armour has stood heavy battering very well, and her broadside of seven 11-inch guns and one 8-inch rifle has always told with signal effect when opened on the enemy. Draught of water about 15½ to 16 feet. Speed 6 to 7 knots, and crew about 440 men.

The defects of the vessel are the unplated ends, which are consequently easily damaged by a raking fire, and involve the rudder and screw more or less, while she can return no fire in either direction. This was particularly and frequently inconvenient in attacking the works on Morris Island, for at certain stages of the tide vessels tail nearly across the channel, and present bow and stern to the beach of Morris Island, so that sometimes it was necessary to delay placing the vessel in position, and at others she would swing round very awkwardly when engaged.

The monitors, on the other hand, were almost equally well defended on all sides, and could fire in any direction. The 'Ironsides' was also open to descending shot, and her scope of fire too much restricted by badly placed ports.

The desire for comparison, which rages just now, can easily be satisfied by bringing the above data in juxtaposition.

Just as they are, the 'Ironsides' is capable of a more rapid and concentrated fire, which, under the circumstances, made her guns more effective than the 15-inch of the monitors. On the other hand, she was restricted by draught to the mid-channel, was very vulnerable to a raking fire, and the direction of her own guns was very limited laterally.

The monitors could operate in most of the channels—could direct their fire around the whole circle—and were almost equally well defended on all sides.

Rear-Admiral Dahlgren, U.S.N.

The defects in both classes of vessels are susceptible of being remedied partially or entirely. The defence of the 'Ironsides' could be made complete, and that of the monitors equally so. The armament of the monitors could be perfected, so as to give all desirable rapidity of fire, but by no contrivance could the 'Ironsides' be enabled to use much heavier guns than those mounted. Yet when such changes were made as experience has suggested, there still would remain to the monitors the lighter draught, choice of guns from the heaviest to the lightest defensibility, and direction of fire around the whole circle; consequently the ability to carry a heavy battery into the least depth of water, with equal power of offence and defence in any direction, and that with half the number of guns carried in broadside by another vessel.

The comparison now made is to be understood as having relation to existing circumstances, and not at all intended as conclusive in regard to the general merits of ironclads.

I presume the department only intended to build such vessels as were best adapted to the service at the scene of war.

Keeping in view the peculiar exigencies of the case, which required light draught and great ordnance power, it appears that the selection of the department could not have been more judicious in preferring a number of monitors to operate from a heavy frigate as a base. . . .

What other style of vessel could the department have chosen? Certainly none that has been built by English or French naval authorities. The 'Warrior' and her class are exceedingly powerful, but could not get within gunshot here.

According to Rear-Admiral Paris the French 'Gloire' draws 28 feet; the British 'Warrior' 26 feet; the 'Black Prince' 23½ feet; even those of inferior class, 'Defence' and 'Resistance,' draw 24 feet. Not one of those vessels could cross the Charleston bar, and would be perfectly impotent to render the least service in any of the operations now being carried on.

On the other hand, there is very little navigable water on this coast which is not accessible to the monitors. They command supremely all that is near the shore, and cannot themselves be reached by vessels of heavier draught.

I have also watched the behaviour of the monitors at anchor through all the phases of winter weather in this exposed situation. . . . The completeness with which four little monitors, supported by an ironclad frigate, have closed this port is well worth noting.

Commodore J. Rodgers, U.S.N.

To sum up my conclusions, I think that the monitor class and the 'Ironsides' class are different weapons, each having its peculiar advantages; both needed to an ironclad Navy, both needed in war; but that when the monitor class measures its strength against the 'Ironsides' class, then, with vessels of equal size, the monitor class will overpower the 'Ironsides' class, and, indeed, a single monitor will capture many casemated vessels of no greater individual size or speed; and as vessels find their natural antagonists in vessels, and only their exceptional antagonists in forts, it must be considered that, upon the whole, the monitor principle contains the most successful elements for plating vessels for war purposes.

Commodore J. Rodgers, U.S.N. — Report to Secretary of United States Navy, April 7, 1864.

Admiral Porter, U.S.N.

Admiral Porter, in his report of 1874, says: 'A great diversity of opinion has existed in the minds of experienced men with regard to the best form of fighting ship; and after examining over 100 different plans of foreign ironclads, I think I am justified in the conclusion that vessels like the "Monadnock" and the "Miantonomah" are better adapted to the protection of our coasts and harbours, and for fighting, than any others yet built. I have seen the "Monadnock" in all weathers, and riding out heavy gales at anchor on our coasts; yet she rode the seas like a duck. This class of vessel has a fore-and-aft, as well as a broadside, fire; and no ship can be considered an efficient fighter unless so constructed.

'A vessel of 600 tons more displacement than the "Monadnock," of 4,000 tons displacement, would carry twice as many guns, and, having light upper works, would be a good sea boat and lively in any kind of weather, the guns could be fitted to lower below the deck when loading, like those of the English gunboats. Such a ship, with the same steam-power, would have greater speed than one of the heavy European ironclads, for she would have much less weight to carry.'

Admiral Porter. — Annual Report, 1874.

The truth is that the original 'Monitor,' if in existence to-day, would not stand one shot from the average rifle gun, and could be run over and sunk by an ordinary ironclad as easily as a river steamer would run over a yawl boat. The double turreted monitors, however, offer a great scope for the talents of constructors and engineers, provided they duly consider what will be required of these vessels.

Annual Report, 1876.

Admiral Porter.

It should be our aim, in making changes, to resist the shot from the 12-inch wrought-iron muzzle-loader, of 35 tons weight, which at 200 yards perforates fifteen inches of solid wrought iron backed by eighteen inches of hard wood, and a skin of 1¼-inch iron plate.

There is now an opportunity to commence what has long been advocated, namely, the construction of a class of vessels that could appear in line of battle, 24 of which would indicate the naval strength of this nation, as the 24 heaviest ironclads of England and France indicate the naval power of those countries, and constitute a force that would drive an enemy from their shores. All monitors that cannot resist the heaviest ironclads will be unfit to enter a line of battle, incapable of preventing the entry of our ports by an enemy, and unable to cope with the heavy guns of ordinary forts. They will, therefore, represent no decided power, either for offence or defence, unless provided with a shield of iron and wood, sufficient to resist the average rifle gun, and with speed to get within striking distance of the enemy.

For fighting purposes I prefer turreted vessels of the monitor class to any others; and the more I examine the various systems of foreign navies, the more I am convinced that we started on the right plan for coast-defence, and should now perfect it by building vessels unsurpassed in invulnerability, guns, and speed, and with a crushing power that nothing can withstand.

Secretary of the United States Navy.

Secretary U.S.N.

Annual Report, 1879.

Although immense sums have been spent by European Powers in the construction of heavily armed and armoured iron ships of war, it has by no means been proved that the plans of these ships are superior to the plans of our monitors. The armament and armour are undoubtedly superior, and the contest for supremacy between ordnance and armour is still going on. There is no reason now apparent for supposing that our type of ironclads, when armed and armoured in accordance with the ideas now prevailing, will be inferior to those of foreign Powers. On the contrary, there is much reason for believing they will be superior.

PAPERS AND OBSERVATIONS ON NAVAL OPERATIONS IN THE AMERICAN CIVIL WAR.

The comparative advantages of the broadside and turret were fully discussed in a paper on the American Navy by Mr. J. R. Hamilton, read at the United Service Institution, June 1, 1868. *J. R. Hamilton.* The American Navy.

If we look at the monitors employed in the war as floating batteries capable of making voyages along the coast, we should be able to do far more justice to the excellence of the conception than if we try to exaggerate them into ocean cruisers. Mr. Welles distinctly states in his annual Report for 1864: 'Only two of the monitor class of vessels, the "Dictator" and the "Puritan," are proposed for sea service. Their success, of which the builder and inventor is sanguine, is among the experiments that the period and the exigencies of the country have imposed upon the department.'

The conclusions to be deduced from the remarkable voyages of the 'Miantonomah' and 'Monadnock' are not sufficient, I think, to promote even these two excellent monitors to the dignity of cruising vessels; that is to say, vessels capable of keeping the ocean under all circumstances, in all latitudes, and in all weather, for six months.

Granting, however, that monitors of the 'Miantonomah' class are capable of carrying, under convoy, their 15-inch guns into any sea, and that they are an improvement on the earlier monitors, let us endeavour to ascertain from the experiences of actual war the value of the latter for the purposes of offence and defence. . . .

The torpedo is peculiarly fatal to the monitor class of vessel. Their sides not being on an average more than 18 inches above the surface, the remaining floating power of the 'Passaic' class, which are 844 tons O.M., is not, according to Admiral Goldsborough's estimate, more than 200 tons. In action everything is battened down, and the chances of egress from below and the gunports of the turrets are very few. The hatches have to be lifted from below with levers, which have to be found and applied at a time of more or less panic or confusion.

The only true monitors destroyed in battle during the war were by torpedoes, and of these three were sunk at Mobile and one at Charleston. It seemed easier to blow a hole in their bottoms with roughly constructed torpedoes than to penetrate their turrets and hulls with the ordnance necessity forced the Confederates to use.

The same want of resources which told against them so fatally in

[illegible]

[illegible] other officer in the United States Navy.

The Admiral, after expressing [illegible] surprise, at the good weather the monitors had made in riding [illegible] gale at their anchors off Wilmington, goes on to speak thus of the 'Monadnock':

'She is certainly a most perfect success, so far as the hull and machinery are concerned, and is only defective in some minor details, which, in the building of these vessels, require the superintendence of a thorough seaman, and a practical and ingenious man.'

Of the other monitors he says:—

'These vessels have laid for five days under fire from Fort Fisher, anchored less than 800 yards off; and though fired at a great deal they were seldom hit, and received no injury. Compared with the "Ironsides," their fire is very slow, and not at all calculated to silence heavy batteries, which require a rapid and continuous fire to drive men from the guns, but they are famous coadjutors in a fight, and put in the heavy blows, which will tell on casemates and bombproofs. The smaller class of monitors, as at present constructed, will always require a steamer to tow them, and to take care of them. . . . I do not know what their real durability is, or would be, in a continuous fire against their turrets. Solid 11-inch or 200-pounder rifle shot are apt to break something where they strike, and I should be much better satisfied myself to be behind wooden bulwarks, and take what comes, than to be shut up in an iron turret, not knowing whether it is properly constructed. This, though, is the prejudice of a sailor, and should have no weight whatever.

'I have only to remark that the principle is a good one, if the vessels are all built like the "Monadnock." The fire of these vessels continued with such vessels as the "New Ironsides" and heavy frigates is very effective, particularly against heavy-plated vessels, bombproofs, and stone and brick walls. I have never yet seen a vessel that came up to my ideas of what is required for offensive operations as much as the "Ironsides." She combines very many good

qualities. The most important is the comfort with which the people on board of her live, though she would be no match for the "Monadnock" in a fight, the latter having more speed.' *J. R. Hamilton.*

I must remind you that the 'Ironsides' was a partially armoured broadside vessel, carrying fourteen 11-inch 7½-ton guns, and two 150-pounder Parrot rifles. Her speed was, I believe, about seven knots, that of the 'Monadnock' about ten knots.

In conclusion, I have only to ask you not to understand that I disapprove of the monitor system as a system. As faulty as many of the American monitors may be in the details of their construction, the principle is a sound one at its core, and for transporting heavy guns in shallow water, and fighting them under such circumstances, I can conceive of no vessels which would surpass them in efficiency and invulnerability, *provided* they were built with solid armour, wood-backing, and Captain Coles's turrets.

The following details from the same paper are inserted in order to show the efficiency of the circular armour on the monitors, and the inverted armour on the broadside ship 'Tennessee' as a protection against the heavy fire from the Confederate batteries:—

MOBILE.—At Mobile Admiral Farragut's fleet consisted of fourteen wooden vessels and four monitors, carrying 125 guns.

On board of the monitors there appear to have been no casualties from projectiles.

In the wooden vessels the Federals lost 52 killed and 170 wounded. Most of this loss was inflicted by the guns of the 'Tennessee.'

The 'Tennessee' was a vessel built after the 'Merrimac' system, with the addition of the knuckle or over-hang. The hull was of oak and yellow pine with iron fastenings. Length on deck 209 feet, beam 48 feet, draught of water 14 feet. The casemate was strongly built, 79 feet long, 29 feet wide inside, the sides of the vessel extending 10 feet from it at the greatest breadth of beam. The sides and extremities of the casemate were made of stout timbers and planking of pine and oak, making a total thickness of backing of 25 *inches*, upon which was placed armour-plating 6 and 5 inches thick, in single plates of 2 inches and 1 inch thick. The slope of the casemate was 30 degrees. . . .

The 'Tennessee' bore no external evidences of the injury inflicted upon her hull by the ramming of the wooden ships, and had she been more manageable as a ram, and been armed with heavy smooth-bores instead of inefficient cast-iron rifle cannon of small

J. R. Hamilton.

calibres, she would in the estimation of her captors have made a better fight.

Her chief defects were in her exposed steering gear, and her motive power.

The following extracts from a paper by Captain Belknap, U.S.N., bring clearly into view the distinctive capabilities of armaments on the broadside and in turrets. The one is best adapted for heavy guns, the other for maintaining a continuous fire, which may have a more telling effect than heavier but intermittent blows.

Captain Belknap, U.S.N.

Captain Belknap, U.S.N.

The United Service, vol. i., January 1879, No. 1, Article 7, Reminiscent of the 'New Ironsides' off Charleston.

The 'Ironsides' got within range of Wagner and Gregg a little past one. The enemy's fire had not sensibly slackened under the efforts of the monitors and land batteries, and as the 'Ironsides' approached the Confederates poured a furious fire upon her.

Quietly and steadily holding on her way until a good position was reached, she dropped anchor within twelve hundred yards of Wagner, or as close in to the beach as the pilot would venture to take her; then the good ship, so long silent, opened her fire with grim and steady precision, and after the gun captains had perfected their aim poured forth a continuous and irresistible fire, which quickly told on the spirits of the enemy.

Their fire soon perceptibly diminished, and at times ceased altogether; clouds of sand would arise from the bursting of the shells, and if the 15-inch projectiles from the monitors, with their enormous bursting charges, disturbed the biggest masses, the havoc made by the fire of the frigate was uninterrupted and kept the sand flying all the while.

On this head Confederate testimony is pertinent. General Beauregard, in an article written for the *Philadelphia Weekly Times*, says, in contrasting her work with that of the monitors, 'that her fire was delivered with more rapidity and accuracy, and she was the most effective engine employed in the reduction of Wagner. . . .'

One morning, when the tide was exceptionally high, the commodore was fortunate enough to get the ship within nine hundred yards of the enemy, and she received thirty-one hits on that occasion, mostly from 10-inch shot, though once in a while struck by a rifle bolt. The round shot always made the most impression on the armour; the bolts rarely struck fairly on end, but generally sideways, and their supposed punching power never had verification in the experience of the 'Ironsides.' . . .

The effect of shot striking the sand-bag protected deck was to scoop off the bag, the shot bounding overboard, and shatter the inch iron plate under the planking, leaving the deck itself almost unscarred; the only detriment arising from the blow was the liability of the deck to leak at the particular spot. . . . *Captain Belknap, U.S.N.*

Had there been two or three ships more like the 'Ironsides' to co-operate with the monitors, what could have prevented the capture of Sullivan's Island and the virtual control of the harbour, finally ending in the occupation of the city?

The millions thrown away on double-enders that would not steer, light draft monitors that, armed and equipped, could not be made to float, and enormous sloops built to rot on the stocks, would have built a dozen armed frigates that would have been of incalculable service in suppressing the rebellion. . . .

Both classes of ironclads were incomparable in their way, and both classes should have been equally tested; and while perhaps the enemy dreaded the approach of the 'Ironsides' more than the united efforts of half a dozen monitors, the latter, with their 15-inch guns, would probably have made short work of the frigate.

The 'Ironsides' in these repeated engagements was often struck, but no man was ever seriously hurt.

M. Dislère.

The most eminent authorities in France fully concur with the officers of the United States Navy in recognising the value of the vessels of the 'Monitor' type for coast warfare. *M. Dislère. Marine Cuirassée, chapter v. p. 127.*

It is stated by M. Dislère, in describing the attack on Wilmington, that the monitors, moored at a distance of from 800 to 1,000 yards from the works, maintained a continuous fire during 72 hours, and fired 50,000 shells from 617 guns. During the whole of this bombardment only one of the monitors had been compelled to cease firing.

Baron Grivel.

Baron Grivel gives a graphic description of the same operations in his essay, *La Guerre Maritime*. He draws the conclusion from the operations against Fort Fisher that the monitors exhibited a conspicuous superiority over every other type for coast warfare. *Baron Grivel. Guerre Maritime, Part I., 'Offensive Warfare,' pp. 56–58.*

The completeness of the protection afforded by the 'Monitor' system is established by numerous illustrations quoted by Baron Grivel.

[illegible]

The 'Montauk' was struck 214 times, and received no injury. In the attack on Mobile the 'Manhattan' was struck [illegible] times by heavy shot, and the turret of the 'Winnebago' [illegible] times. The 'Chickasaw' was equally exposed. In none of these ships did any casualties occur among the crews, while in the wooden corvette 'Brooklyn,' which was struck 23 times, there were 54 killed and wounded, and in the 'Hartford,' a vessel of the same type, the number of killed was 25, and severely wounded 28.

'Army and Navy Journal.'

Army and Navy Journal, New York, November 16, 1877.

These floating batteries, developed in America, by the genius of Ericsson the Swede, into the famous monitors, remain to-day the only practical ironclads that have yet been devised. Designed for a specific purpose, that of resisting heavy ordnance, no other type of armoured vessel has yet proved so successful for the attack and defence of fortified harbours, where actions are fought in smooth water. For that purpose monitors are unrivalled, and they never failed during the American Civil War to defeat casemate ironclads, even those of far superior forces. The low freeboard and the wave-washed deck, which to a sailor are so contradictory of all previous notions of safety at sea, are the essence of the monitor system, as leaving the smallest target for the enemy's shot. Their form and purpose alike forbid the use of monitors as sea-going cruisers to fight in all weathers. A monitor can go to sea, but can never fight at sea with any degree of safety such as accrues to a wooden ship. Whether any other ironclad can do so remains to be proven, the facts as developed being all the other way. The victories of Farragut and Tegetthoff, leading wooden ships into action against ironclads and sinking or capturing the same; the impunity of the 'Shah' and 'Amethyst' in their recent conflict with the freeboard ironclad 'Huascar'; the failure of the Turkish ironclad fleet to accomplish anything of value in the present Eastern War, all seem to point in one direction, the eventual abolition of the costly and comparatively useless 'sea-going ironclads,' so called, from the modern navy list. The battle between guns and armour is nearly fought out under modern conditions, as it was in the seventeenth century under simpler conditions, the victory remaining with the guns.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION V.

ARMAMENTS.

RELATIVE IMPORTANCE OF THE GUN AND THE RAM.

M. Dislère.

M. Dislère. — *Guerre d'Escadre*, Paris, 1876, p. 48.

I put the artillery in the first place as a naval weapon, for although in the engagement of the future it may play a secondary part with reference to the ram, we must nevertheless depend upon the gun in the earlier stages of an engagement at long range, when it is sought to compel an enemy, having an advantage in speed, to offer battle. Again, when the blow of the ram has been avoided, and while the ships are passing broadside to broadside, it is with the gun that we must attack the weak places in an enemy who has parried the blow of the ram. Such an attack can be made with more certainty with the gun than with the spar or the towing torpedo.

Mr. J. Knox Laughton, M.A.

Mr. J. Knox Laughton, M.A. — From an essay on 'Naval Tactics.'

In the days of wooden ships a shell striking, even at a very acute angle, was tolerably certain of fulfilling its mission; now, in these days of 12 or 20 inches of iron plating, the heaviest shell at its greatest velocity, when fired without great deliberation, is more likely to glance than to penetrate; so that it is quite allowable to suppose that a broadside of modern times might altogether fail of its effect. . . .

It would be here out of place to attempt any detailed comparison of the power of the guns; but from a careful consideration of the many differences, it is impossible to avoid the conclusion that relatively to the work it has to do, the artillery armament of a 'first-rate' is much, very much less formidable than it was fifteen or twenty years ago; and that, although in target practice the modern gun is found possibly effective at ranges of 2,000 or 3,000 yards, on active service the chance of not hitting the object at all, and the chance of

glancing on hitting are so great, that the chance of a penetrating shot at a long range is very small, and cannot be held to have much practical value. . . .

Mr. J. Knox Laughton, M.A.

In days yet to come, when our naval architects, aiming at 'handiness' as the most desirable offensive quality of a ship, have rendered possible a precision and quickness of manœuvring far beyond our present understanding, it may be a question whether, with a weapon so formidable as the ram, the great gun should not be virtually laid aside; but the time for such a question has not yet come; the gun must still be held to be, primarily, the armament of our ships, though secondarily the ram must enter largely into any scheme of battle, and of offensive or defensive evolutions.

ARMAMENTS TOO LIGHT IN PROPORTION TO DISPLACEMENT.

Sir John Commerell.

UNARMOURED FRIGATES SHOULD BE ARMED WITH ARMOUR-PIERCING GUNS.

Vice-Admiral Sir John Commerell, K.C.B. — In discussion on Mr. J. Scott Russell's paper. United Service Institution, June 8, 1877.

Mr. Scott Russell has drawn attention to the offensive armaments being exceedingly weak in proportion to the size of our ships. We have ships of some 9,000 tons displacement, carrying only 140 tons of ordnance. Is that flotation necessary? We have a ship of 11,000 tons displacement, carrying only 320 tons of ordnance. Is that flotation necessary? Would not such a ship be more fitted to fight an enemy if she could substitute for some two or three hundred tons of defensive armour that weight of offensive ordnance? Mr. Scott Russell has also drawn attention to the advantage of our going back to the good old custom when every ship in the Navy carried guns of very much the same type, capable of penetrating not only vessels of her own size, but the sides of any enemy, however large the hostile vessel might be. We have had in the last week an illustration of what I two or three times pointed out in this theatre as a possible occurrence. We have had a British ship—one of the most splendid frigates in existence—and a splendid corvette, sent out to the other end of the world to protect British interests. These two British frigates have fought, not sister ships as they were designed to fight, but a wretched little Peruvian vessel of about one-fourth their size, and armed with guns, I venture to say, about one-seventh the weight of those used by the two British ships. What is the consequence? Do the British ships knock the wretched little Peruvian gunboat into lucifer matches? No, they do nothing of the kind, and, as I have often pointed out in this theatre, they could not do it, for the simple reason that they have been sent to the other end of the world furnished with guns which cannot perforate the armoured sides of the little Peruvian. British corvettes and

frigates are almost inoffensive when called upon to attack armoured gunboats like the 'Huascar.' I do not think that British corvettes, sloops, or frigates, ought to be without armour-piercing guns, and without rams, so as to be placed in such a position that any wretched little ironclad shall be able to stand up against them. The guns of wooden ships are not only too small, but we deliberately selected for the British Navy that gun which we were officially told gives *decidedly the lowest velocity*, and therefore the weakest blows. *Vice-Admiral Sir John Commerell, K.C.B.*

Rear-Admiral Scott.

ARMAMENTS OF IRONCLADS NOT PROPORTIONATE TO THE WEIGHT OF ARMOUR AND DISPLACEMENT.

Rear-Admiral Scott.

Discussion on Naval Prize Essay, 1878. Royal United Service Institution.

I believe in all our ironclads, from the 'Inflexible' downwards, the due proportion of the power of attack is now being sacrificed to the defence, but the whole naval policy of our country has heretofore been and must continue to be one of 'attack.' Our power mainly consists in offensive warfare, and *not* in remaining on the defensive. I therefore wish to point out that all our turret vessels share equally with the 'Inflexible' in deficiency of offensive power. They all have very few guns, and these are in many cases dependent upon machinery, which is exceedingly difficult to keep in working order, which requires an engineer to manipulate, and which may break down at a critical moment. These vessels have neither supplemental heavy ordnance nor small guns, so that they are dangerously exposed to the attacks of the smaller torpedo-boats.

OPINIONS IN FAVOUR OF HEAVY CALIBRES.

Admiral Pothuau.

Admiral Pothuau. — Debate on French Naval Estimates, 1879.

Guns of 48 tons are being mounted on board ship—guns of 74 tons are being manufactured—guns of 100 tons have become indispensable.

M. Dislère.

M. Dislère. — *La Marine à l'Exposition*, 1878, p. 52. Report by M. Dislère, published by French Ministry of Marine.

The direction in which opinion is tending is plain: it will result of necessity in concentrating in the minimum number of guns the offensive power of the heavy ordnance.

MIXED ARMAMENTS.

BRITISH AUTHORITIES.

Vice-Admiral Randolph.

Vice-Admiral Randolph.

End-on fire tactically considered. Lecture delivered at the Royal United Service Institution. Vol. xxiii., p. 32.

Secondary, as I think, to this first consideration, the side armament might consist advantageously of guns no heavier than the 12-ton, because more could be carried, and be fired, I believe twice if not thrice, as quick as the heavier. Thus four of these would fire from eight to twelve times, and five of them from ten to fifteen times, whilst three of the larger calibre of 25 or 35 tons would fire only three shots, *i.e.* one each. I am aware that it is contended that one of the heavier projectiles will produce an effect three times as great as one of the other, but I think even this is only on the assumption that it strikes perpendicularly and upon a target that it cannot penetrate.

Now I think it almost certain that in passing a ship backwards and forwards, or at any stage of a *mêlée*, and in the inevitable difficulties caused by smoke and other obstructions, when snap-shots must be the rule, there will be more value in frequent opportunities than on the difference of effect between smaller or larger projectiles, always supposing that the smaller has a fair penetrating or smashing power upon the target of the moment. Should this be impervious to the 12-ton—and it must be an armour exceeding 9 inches thick—then my ram may well be content with her double end-on attack.

In silencing earth batteries, as distinct from destroying forts of solid masonry, the value of a sustained fire from numerous guns will hardly be questioned; nor in case of being opposed to numerous or unarmoured enemies.

Sir Spencer Robinson.

Sir Spencer Robinson.

The most experienced artillerist will not fail to miss a great many times. That leads me to remark upon a subject which Admiral Randolph has discussed, and I think very justly. I prefer a small

Sir Spencer Robinson.

Discussion on Admiral Randolph's paper.

number of guns to one large one, because, although the effect of a very large gun is something so great that our minds can hardly grasp it, yet a small number of guns may often secure your planting two or three decided hits when you will not succeed in getting a smashing blow from a great gun. I cannot help thinking—indeed, the principle is one in which everybody who has had experience will agree—that it is not possible to make so sure of a projectile doing its work when you can get that projectile off once in three or four minutes, as when you have four or five which you can get off in every two or three minutes. Your projectile must be an effective one. It is no use throwing an egg against a brick wall. The projectile must be capable of penetrating and doing the mischief that penetration must cause, and therefore it must be of a certain size, because you are certain you will meet armour-plates of great thickness, and more and more so every day. I have heard mention of a gun for which I have the greatest possible respect, and which I think could be used effectually against ironclads of the present day—that is, the 38-ton, 12·4-inch calibre. That is a most powerful weapon, and it has been supplied to the foremost turret of the 'Thunderer.' I do not consider that that projectile is too large to be effectively used in a ship at sea, and I believe it will be the master of almost every ironclad that foreign Powers are likely to send to sea, or that we ourselves can send to sea, in all weathers and in all places. When we come to the monster projectile weighing 1,700 lbs., fired with a charge of 370 lbs. of powder, such as the 'Inflexible' fires, we must consider what a long time must elapse, if your shot should miss, before you can fire another at the enemy. I would rather go to sea with four 38-ton guns than with one of the 'Inflexible' class. A shot from the 'Inflexible' gun, with a projectile of 1,700 lbs. and a charge of 370 lbs. of powder, will have a total energy on impact of 29,607 tons. Of course, such a blow as that will be most smashing and effectual. But, then, you must hit, and the chances that you will not hit are not diminished the least in the world by the size of the projectile. The time that you will lose in loading the gun again, and getting the right elevation, will very much diminish the chance of bringing the action to a satisfactory close.

Rear-Admiral Scott.

Rear-Admiral Scott.

A great deal has been said about the penetration of armour, and a great deal of nonsense is still talked about guns beating the armour, and *vice versâ.* It is the greatest possible rubbish, for you have only

to increase the power and number of guns to destroy any thickness of armour. The armour cannot return the fire, and whatever the defensive armour of the ship may be, she must carry guns which will return and subdue the enemy's fire. Our principle in England must be that of quick and sharp *offence*, such as has always proved the best *defence* in our naval wars. I am not at all sure that in mounting very large guns, of 80 tons or more, we are not getting into very serious difficulties. The large guns can be easily hit; and whatever England may do towards increasing the accuracy of firing at sea, other nations are greatly improving their practice, and hence I believe that such a large gun as one of 80 tons will be easily hit; I have not the slightest doubt that a 64-pounder shot fired at a high velocity would so damage that big gun as to make it utterly useless. This is a matter for serious consideration. I think it is also a matter to be carefully considered whether the guns are not really the most important things to be protected, or at all events next in importance to the engines.

Rear-Admiral Scott.

Remarks at the Institute of Naval Architects, 1876.

The gradual development of bow and stern fire spoken of by Captain Colomb is no doubt correct. What is required is to have each war ship armed with light guns to play upon gunboats, and with heavy guns to attack powerful batteries.

Royal United Service Institution. Discussion on broadside fire and a naval war game. Vol. xxiii., p. 528.

Commander Dawson.

'I, as a gunner, believing in offensive weapons, object very much to the weight of armaments carried being diminished further.'

Commander Dawson.

Institute of Naval Architects, March 23, 1877.

The late Admiral Farragut, in the American Civil War, preferred going into action with many guns in a wooden frigate rather than with few guns in an ironsided vessel.

His argument was, 'Hit your enemy as hard and as often as you can, and do not give him time to breathe, or to see where to hit you.' I am not prepared to sacrifice another ton of ordnance for an additional ton of armour.

Commander Gerard Noel.

Captain Noel.

With regard to the question of the advantage gained by mounting a small number of the heaviest guns on board ship, it is evident that the first and most important object in the employment of artillery is to hit the mark; and the second, to hit it as often as possible. For this, accuracy and rapidity of fire are needed. If the number of

Captain Noel.

Prize essay, Royal United Service Institution, 1876. 'The Gun, the Ram, and the Torpedo.'

guns is diminished and their weight increased, the fire naturally becomes slower. Again, we may consider that the value of the artillery fire of a ship will be diminished by at least one-third if she is moving at high speed, and that another third will be lost if the object is also rapidly changing its position. If then, for very heavy guns, we add the difficulty of ensuring in any human being that amount of unshaken nerve and cool precision which will be indispensable for the effective use of a weapon, each discharge of which is of such immeasurable importance, we shall find the value of the system of a few heavy guns reduced to a very narrow limit.

Let us now endeavour to estimate the value of the lighter ordnance.

I maintain that if, of the large number of shell in a broadside, half can be made to take effect and to penetrate the weaker parts of even our finest sea-going ironclad, the guns doing this will render most important services. In addition to this the 'Agincourt's' battery could fire two broadsides to the 'Devastation's' one.

Commander J. B. Hayes.

Commander J. B. Hayes.

Essay on 'Great Britain's Maritime Power,' written in competition for the prize, and printed by order of the Council in the *Journal of the United Service Institution*, vol. xxii., 1878.

Although heavier guns must be carried in special ships to compete with foreign Powers, the 35 or 38-ton gun may be taken as the most suitable for the B and C classes, and for the 'floating gun-carriages' that will be necessary for attack and defence in shallow water.

No first-class ironclad should carry a less powerful plate-piercing gun than the 10-inch of 18 tons, which combines great power with perfect handiness, and may, therefore, be considered the most effective gun for general service. . . . The remainder of their armament should consist of 12 or 20-pounder guns for firing at torpedo-vessels, the enemy's ports, &c.

Swift torpedo-vessels will not be able to carry any very great thickness of armour, which will, however, probably be of very superior metal, and in the turtle-back shape. To meet this it may be considered advisable to construct Gatling guns carrying elongated steel bullets with flattened heads, and weighing about one pound, for the purpose of penetrating the steel mantlets of the torpedo vessel.

For the older ironclads and the cruisers of frigate-class, the 9-inch gun of 12 tons should be carried, and if possible 10-inch guns should be carried *en barbette* in the bow and stern as in the 'Téméraire.'

As our wooden cruisers may have to engage ironclad ships and strong forts (stone, earthwork, or even ironclad), it is essential that at least the larger cruisers should carry some 10-inch and 9-inch guns, and in the smaller vessels they should carry two or more as heavy guns as possible at the bow and stern. *Commander J. B. Hayes.*

The 6½-ton gun is the smallest that should be carried by any but gunboats; it will pierce some of the weaker ironclads at moderate range, and carries a double shell with a bursting charge of 10 lbs. 12 oz.

Captain the Hon. E. R. Fremantle, R.N.

Generally, as it has been ably pointed out by Captain Colomb, who is the only authority to whom we can appeal as having even attempted to solve the relative positions of the gun and the ram, the fewer the guns carried, whatever their size may be, the greater the trust which must be reposed in the ram. Heavy broadsides, even from numerous 9-inch and 10-inch guns, in these days of thick plating and partial protection, are probably more demoralising and effective than the lesser number of shot from larger guns. The old adage about 'not putting all your eggs into one basket' applies equally to guns as to ships. As Nelson said, 'In a naval action something must be left to chance,' and those who fire the largest number of shots must have the greatest number of chances. *Captain the Hon. Edmund R. Fremantle, R.N.* — Naval Prize Essay. Royal United Service Institution, 1880.

Another new departure is the open declaration that the big ship and the biggest possible gun is at last being recognised as by no means the best system, and the Admiralty now considers that two 43-ton guns are preferable to one 80-ton gun, and that two ships with the lighter gun are better than one ship only carrying half the number of 80-ton guns. *Army and Navy Gazette,* March 1880.

EXPERIENCES OF AMERICAN CIVIL WAR AND OPINIONS OF AMERICAN AUTHORITIES.

Rear-Admiral R. V. Hamilton.

The next action I shall describe is Farragut's passage of the defence of the entrance of Mobile Bay, defended by Fort Morgan, originally a brick structure, supplemented according to the recent *Rear-Admiral R. V. Hamilton.*

Rear-Admiral R. V. Hamilton.

'On Facts connected with the Naval Operations during the Civil War in the United States,' a Paper read May 24, 1878, at the Royal United Service Institution.

experience gained by the Confederate engineer, by sand batteries, &c., mounting 136 guns, and a line of torpedoes extended partly across the channel.

The fleet consisted of five corvettes, mounting 20 guns on an average, and three mounting 16, each having an attendant gunboat lashed on the port or off side from the batteries, and the four monitors were placed in-shore. On the engaged broadside therefore the Federals opposed 74 guns to the fire from the batteries, mounting, as already mentioned, 136 guns. I cannot, however, ascertain how many bore on the channel; but, as the passage had not been attempted sooner, there must have been a considerable number, as so dashing a leader as Farragut declined attacking without monitors. I do not think I am overstating the case when I allow at least 50 guns; and as all the ships' guns could not bear at once, in this instance I do not think their fire was superior in point of numbers to that of the defence, supplemented as it was by a raking fire from the 'Tennessee' and her consorts. Farragut, as usual, relied on the rapidity of his own fire as the best defence against the enemy; not to fire till they did, then use shell and shrapnel; grape when within 400 yards. Gun crews on poop, forecastle, and in tops, were to be removed when within grape range, till passing it. His flag captain reports after action, 'The rapidity of our fire, together with the smoke, so completely disordered the enemy's aim—we passed the fort with no great injury or loss of life.'

Mr. Holley.

From *Ordnance and Armour*, New York, 1865, chapter ii. pp. 220, 221.

General Conclusions.—The work demanded of guns for ironclad warfare, is not the mutilation of armour, but the disabling of the active enemy—men, guns, and machinery—within it. . . .

Punching shot of moderate diameter, and light enough to receive a high velocity, meet with the least resistance and waste the least power in uselessly mutilating and vibrating the armour: they strike the enemy at once. The combination of the two systems—heavy racking and smashing shot, and smaller punching shot—utilises both. The latter, without losing its independent usefulness, renders the heavy shot effective. . . .

But if two kinds of naval guns are to be used—and this would appear to be the better system—a smaller gun would stand higher relative charges, and thus give higher velocities to punching shot, and a larger gun—perhaps a greater calibre than 20 inches—would most promptly and effectually smash in a ship's side, throw off her armour, and impair her sea-going as well as her defensive qualities, especially when her armour was riddled, or shattered and weakened at different points by smaller and swifter projectiles.

FRENCH AUTHORITIES.

M. Marchal.

M. Marchal.

'Tableau et classement des Marines Militaires.' *Revue Maritime,* January 1878.

We will now proceed to make an estimate of the relative value of guns of different calibres. Our calculations must depend not only upon the nature of the gun itself, but also upon the service in which it is to be employed. Against an ironclad the 100-ton gun is worth more than twenty-five 4-ton guns—against an unarmoured cruiser a great number of small pieces will be more effectual than the same weight concentrated in a limited number of guns. A recent illustration shows how the guns lose their efficacy when employed in a different service from that for which the vessel carrying the particular armament is best adapted. In the engagement between the 'Huascar' and the 'Shah' the projectiles of the ironclad were too few in number, and failed to reach the vital parts of the cruiser. On the other hand, the shells of the cruiser were almost incapable of penetrating the armour of the monitor. We must therefore divide our guns into two classes, according to the service for which we propose to employ them.

Captain de Cuverville.

Captain de Cuverville.

'Quelques Reflexions sur les ordres de Bataille.' *Revue Maritime,* (1876), LI. p. 698.

In order to pass in review the principal contingencies which may take place, let us in conclusion suppose that two adversaries having emerged from the thick of the combat, have challenged each other to a mortal engagement when no assistance can possibly be rendered by a friendly ship. Let us suppose that they have approximately the same speed and the same evolutionary qualities. Each commander has full confidence in his guns. The duel between the 'Alabama' and the 'Kearsage' is to be repeated. The two ships will doubtless manœuvre with a view to ramming and to bring the struggle to a close by one decisive blow. But if the skill of both combatants is equal, these attempts can bring about no other result than that of causing the adversaries to cross each other's path or to revolve round each other in concentric circles, and during this period a constant cannonade would be kept up. The guns of heavy calibre will doubtless be used with telling effect, but a good armament of moderate calibres, combining accuracy with rapidity of fire, will in this case also be found of immense value.

NAVAL GUNNERY.

PERCENTAGE OF HITS. UNFAVOURABLE OPINIONS.

Captain Colomb, R.N.

Captain Colomb, R.N.

Paper on the 'Attack and Defence of Fleets,' read at the Royal United Service Institution, April 3, 1871.

The 'Monarch' has the fewest and heaviest guns of any sea-going ship in the Navy, and she exercises her gun power over a larger arc than any other. She is the embodiment of the idea that the gun is the decisive weapon at sea, to which all others must give place, and that this weapon is most powerful when mounted in limited numbers, of the greatest size, and with the largest arc of training. . . .

How many shot will strike the hull of a 'Monarch' in a given time in the open sea, and what amount of damage will they do? . . .

My figures must be, for these reasons, very imperfect; but I am obliged to use what I can get. . . .

It appears safe to conclude from these figures that the 'Monarch' is not *liable* to receive more than four-fifths of the shot fired at her at 1,000 yards; and if the chances of being hit vary directly as the distance, at 2,000 yards the 'Monarch' is only liable to receive two-fifths of the shot fired at her. . . .

Taking the experiments carried out at Vigo between the 'Monarch,' 'Captain,' and 'Hercules,' for what they are worth, it appears that the three ships fired for five minutes each at a rock distant about 1,000 yards, which was estimated to be 600 feet long and 60 feet in height, or twice as long and four times as high as a ship. 'Hercules' fired seventeen shot, of which ten hit; 'Captain' fired eleven shot, and made four hits; 'Monarch' fired twelve shot, and made nine hits. Speaking roughly, as I am bound to do with rough figures, it would appear that a ship such as the 'Monarch' would under those circumstances have been hit three times by the 'Hercules,' once by the 'Captain,' and say three times by the 'Monarch.'

We have seen that ·8 of the shot fired would have hit a 'Monarch' at 1,000 yards, the platform being steady; we now find from the foregoing experiment that ·147 of the 'Hercules'' shot, ·09 of the 'Captain's' shot, and ·187 of the 'Monarch's' shot might be expected to hit her at sea in smooth water, when the distance did not materially vary. . . . *Captain Colomb, R.N.*

I take a mean position between the results deduced from the Vigo experiments and those taken from prize firing, and I lay it down that 10 per cent. of the 'Monarch's' shot will strike a 'Monarch' in action at 1,000 yards.

We have seen that the 'Monarch' is, in her vital parts, impenetrable to shot from the 25-ton gun at 1,000 yards when struck fair. Practically, I believe she will be so seldom struck fair, that no part of her plating is vulnerable until within 1,000 yards, and in anything approaching the end-on position I feel bound to extend this invulnerability to within 500 yards of her adversary. . . .

If a ram were to attack, a larger ship could best defend herself by a large number of light shell guns. Such might be easily employed in a broadside ship, in addition to her plate-piercing armament, but could not be employed in the 'Monarch.' If, however, it is found that a ram of 1,000 tons can be so plated as to resist all but the heaviest shot when striking at an angle of 45 deg., then it appears to me there is no help for the larger and more unwieldy mass such as the 'Monarch,' except the towing torpedo.

If light swift torpedo vessels are designed, a heavier and slower ship must meet their attacks by multiplying the numbers of lighter guns carried.

On the whole, it does appear to me a matter of very serious consideration, whether this struggle after guns which will pierce the heaviest plates at long range has not overshot itself—whether the point has not already been passed at which the reduction in the number of shot which can be fired per minute is compensated by the increased power of the gun.

Mr. Barnaby.

The experiment made on July 5, 1872, in Portland Harbour, was designed to test the endurance of certain parts of the turret arrangements in the 'Glatton,' when exposed to fire from a 600-pounder gun at 200 yards, with charges of 85 lbs. of pebble powder. . . . *Mr. Barnaby, C.B.*

I witnessed the firing from on board the 'Hotspur,' and I saw

Mr. Barnaby, C.B.

From a paper, 'Lessons from the "Hotspur"-"Glatton" Experiment,' read by Mr. N. Barnaby, C.B., before the Royal United Service Institution, March 3, 1873.

the care with which the ships were moored at 200 yards range, and the pains taken to get the precise amount of elevation supposed to be required (21'). Four sighting shots were fired, and then, although there was no wind, and scarce a ripple on the water—the first shot at the turret itself hit the sighting bull's-eye, placed 28¾ inches above the point on the turret which it was intended to strike.

The next shot, fired, with 15' elevation, hit the turret, but at a lower point than was intended, as it struck near the joint of the armour; and it hit also on one side of the centre line between the ports, so that it came upon one of the bolts which it had been intended to avoid.

The next shot was intended to strike the turret about 17 inches above the deck, but instead of doing so, it struck the deck, indented it, cracked the glacis-plate, and then did its best to lock the turret by forcing its way 13½ inches into the armour and stopping there.

This inaccuracy was probably due to a slight motion in the 'Hotspur,' only perceptible upon very close observation.

With this amount of inaccuracy, under circumstances the most favourable that can be conceived, what inaccuracy and chance shooting there must be on the open seas, when the gun and gunner are being rolled through vertical arcs not of minutes but of degrees; when the ship is also lifting and then lowering the gun bodily several times in a minute through feet of vertical space, at one time adding to the upward motion of the gun produced by rolling and then abating it, so that in allowing for this motion in the shot when it leaves the gun, the gunner must at one moment allow for roll and heave together, and at the next for the difference between the two! I am not able to say—I suppose no one could—how many times in a minute the 'Monarch' or 'Captain' would have been able to have fired with turret guns in the heat of an action, but a good test of rapid firing at a large mark at about 1,000 yards has been made with the 'Monarch' and 'Hercules.'

M. Dislère.

M. Dislère.

Guerre d'Escadre, Paris, 1874, p. 50.

Les canons du plus gros calibre, il ne faut guère songer à les utiliser à grande portée, avec l'incertitude qu'offre le tir dans ces conditions.

Rear-Admiral Hamilton.

Rear-Admiral Hamilton. — United Service Institution May 24, 1878

In the combined siege of Port Hudson, the 'Essex' ironclad, 9 guns, was engaged repeatedly from May 23 to June 26 with batteries mounting two 10-inch, two 8-inch Columbiads, and two rifled 6-inch guns. 'During these engagements "the batteries were silenced and men driven from them three times." "Essex" fired 738 shells, and mortar vessels 2,800 shells. It was estimated 1,000 shot and shell were fired at "Essex;" 23 struck her hull, and her awnings and wind-sails were cut up—casualties, six wounded.' Comment is as unnecessary as it would be to give the many more similar facts I could bring forward, while I have given the worst done by batteries as far as I have ascertained. Mr. Goschen, as everyone probably remembers, stated in the House of Commons that he was informed by an eminent authority that it would take 300 hits to reduce the 'Inflexible' to the well-known 'riddled and gutted condition.' From these facts we can all judge how very improbable such an event would be, and how many shots must be fired before she would be struck so often.

PERCENTAGE OF HITS. FAVOURABLE OPINIONS.

Lieutenant Eardley Wilmot.

Lieutenant Eardley Wilmot. — Prize Essay. Royal United Service Institution, 1878.

Not a few are of opinion that a number of moderate sized guns are superior to a less number of greater weight. This is perhaps on the assumption that a large percentage of shots will be thrown away in the heat of action; and no doubt where the fire is left in the hands of men whose vision is limited by the confines of a small port, and whose training, however good, has not led them to calculate how minute an error at the moment of firing will affect the result, we cannot hope to see every shot strike the object. But if, on the other hand, we concede that firing by broadside will in the future be the usual mode of procedure in a naval action against armoured vessels, we may expect that this defect will be greatly overcome. The employment of electricity also will decrease the percentage of waste shots.

COMPARATIVE IMPORTANCE OF BROADSIDE AND BOW FIRE.

Captain Colomb, R.N.

Captain Colomb, R.N.

'Lessons from Lissa.' United Service Institution, *Journal*, vol. xi. p. 104.

However we arm our ships with guns, whether on the broadside or turret principles, or on a combination thereof—one thing will remain certain, that the best position for delivering the fire will be broadside on to the object. But if the object be an approaching ram, the best position for attack by guns is the worst position for receiving her. Again, a ship to use her ram in the best manner puts herself end-on to the object to be attacked. But if the object be a ship defending herself by artillery fire, this end-on position is the best for receiving it. For it is no longer as it used to be in this matter; 'raking broadsides' are not now to be dreaded. A ship end-on offers the smallest target to the enemy, and gains any advantage there may be from presenting her plates at an angle to the line of fire. She is, however, in the worst position for using her guns.

Prize Essay, 1878. Royal United Service Institution.

I have never heard a serious argument in favour of the bow fire. Unless a ship is pretty close to her enemy, and in a particular relative position, there is no objection in life to her presenting her broadside, and an end-on battle must become a broadside one after the lapse of a very few minutes. It is certain, because a ship is longer than she is broad, that the broadside fire can always be made more powerful than the bow fire. It is also certain that the vertical target presented by a ship end-on is less than that presented by a ship broadside-on.

Admiral Ryder.

Royal United Service Institution, June 21, 1878.

Admiral Ryder.

As to the relative value of beam and end-on fire Captain Colomb attaches much larger importance to the beam than the end-on fire. I ask for both. I am not prepared to give up end-on fire.

Commander Hayes.

BOW AND STERN FIRE.

The value of bow and stern fire has been questioned on the following grounds:— *Commander Hayes.* Essay printed by the Council of the United Service Institution, 1878.

On ships meeting with intent to ram, the smoke of a bow gun would obscure the captain's view at a critical moment.

The closing of the two ships, and their separating if they failed to ram, would be so rapid that only one round could be fired from each bow or stern gun, and with very slight chance of hitting.

Bow and stern fire under the above conditions would probably be useless, and bow fire positively injurious. It may be assumed that in fleet actions and in actions between single ships when ramming is the object in view, the guns will be laid near the beam and fired in broadsides in passing the enemy, when failing to ram.

Admiral Scott.

There is the further point to be considered, which is, that our merchant vessels are not unlikely to be armed so as to play a prominent part in future warfare. A couple of such vessels would run an unarmoured vessel very hard if she had only broadside fire; they would not allow her to use that fire, for they would follow her up closely, just as Admiral Elliot has pointed out in the case of a single combat; he has, I think, exhausted the arguments on that point. My own belief is, that our efforts should be directed to arranging all the heavy guns of a ship to fire from ahead to astern. There is no difficulty in doing this, it is merely carrying out a little further what has been already done in the case of the 'Audacious' class. The guns could be mounted within circular projections, so as to fire from all round the broadside to within 13 deg. of the line of keel. This wide range of 154 deg. on each broadside, with all the heavy guns on each side, is very important, for it leaves only 52 deg. out of 360 deg. which are not covered by the full broadside fire. Then, again, the ship is not always in smooth water, but you want, so far as you can, to keep the ship *steady* when firing her broadside. The circular projections would not only afford the power to do this, but you would be able (in consequence of the wide range of fire), whether advancing or retreating, to fire the whole of your guns, with a very slight alteration of course. Captain Colomb says he would yaw and fire his broadside: my experience has been that when you port the helm over the *Admiral Scott.* Naval War Guns, debate at United Service Institution, vol. xxviii.

Admiral Scott.

ship will heel, and you have wild firing, and if you attempted to fire while the ship was swinging, accuracy was very difficult of attainment. What is wanted is that the heavy guns should be able to command an arc of fire from ahead to astern, and I believe that future progress will be in the direction of placing light steel armour outside the guns, and giving the ship a steel deck, extending from the ram-bow to the stern, and throwing away the rest of the usual defensive armour. I think, however, it is very difficult to apportion the relative values of broadside and bow fire; both seem to me so necessary that, like the arms and legs of the human body, you cannot dissever one from the other without materially injuring the whole fighting power of the ship.

Admiral Sir George Elliot, K.C.B.

Sir George Elliot, K.C.B.

Remarks in debate on Captain Colomb's paper on naval war guns.

I am a very strong advocate of end-on fire and end-on attack. I cannot go so far as the French Admiral in saying that two ships *must* begin by meeting end-on, because I consider that the ship which has the weaker bow must necessarily avoid meeting his adversary's end-on attack. If a ship is a broadside ship she must have the weaker bow. And when I say I fight an end-on fight, I must be allowed to take the same weight of guns as my enemy, and the same weight of armour as my enemy, and do what I like with them. I am not to be bound (as Captain Colomb proposes) to put my armour in midships and my guns pointing to the bow and stern, but I take my armour and put it where I like, and how I like, and mount my guns as I like. One of the first considerations in constructing a ship intended to ram should be to strengthen the bow, because if I did so, and if I had any reason to believe that my enemy was a broadside ship, I should conclude he must have his armour to protect the broadside guns in midships, and that his bow must be comparatively weaker than mine, and that knowledge would greatly influence my mode of attack. To show what I mean, there were two ships lying end-on alongside the Dockyard at Portsmouth, one the 'Dreadnought,' and the other the 'Inflexible.' Out of curiosity I put a question to an experienced old officer who was in charge of the 'Dreadnought,' which ship's armour-plating came right forward, that is to say, that there was an armour water-line belt meeting at the bow. I said, 'Suppose these two ships were ramming each other, bow to bow, at a speed of 10 or 12 knots, what would be the consequence?' 'Well,' he said, 'I do not suppose I should bring up the "Dreadnought" until I came to the

central citadel of the "Inflexible."' I quite agreed that the 'Inflexible' having a weak bow, there would be nothing to stop a stouter bowed ship destroying her in the event of end-on collision. In a ship constructed for end-on fighting I would decidedly run at the other ship, and as the broadside ship dare not run at me she must turn away from me. I do not believe I shall be denied that. If she dare not run at me, she must turn away at a sufficient distance to avoid being rammed. But, my object still being to keep an end-on position, directly I see my adversary move, I turn towards him, steer at full speed, and continue the same tactics. Whatever he does I go straight at him. He may discharge one or two broadsides at my armour-plated bow, which is well protected, and in return my bow guns will continue firing on him; but he must soon commence a running fight, and then what becomes of him? He has no stern guns and no armour protection astern, but still I am firing my bow guns at him, and I have a protected bow. I have my bow strengthened by horizontal decks, and in every way made as stiff as possible, having applied a certain portion of the weight of armour for that purpose. The consequence is he turns away and I follow him. I ask at what distance will he turn away? He would not turn away out of gunshot range; if he does he runs away. The moment he turns away within gunshot range I turn towards him. The end of it must be that I come on his quarter at last. Now I say if I once get on his quarter within a certain distance that ship ought to be mine. His stern is in every respect more vulnerable than my bow, and there is nothing to protect his crews or his rudder from my bow fire. You talk of making circles, but if my sole object is to close, if I once get on his quarter within a certain distance my adversary never can turn round again. He dare not show me his broadside. Every time he attempts to turn I take the inner circle and get nearer and nearer to him, and the consequence is he will have to fight that battle out, running away the whole time, and that is all he can do. If my bow is stronger than his stern I ought to win; therefore I do not agree with Captain Colomb in some of his remarks where he said two ships must avoid end-on meeting. I would not avoid it. I would invite it.

Sir George Elliot, K.C.B.

Mr. Scott Russell.

One word only on a professional point, which must lead to a little confusion as to the mode of carrying on this matter. Admiral Elliot said he would like to take the armour away from the middle of the ship and place it on the end of the ship if the guns were carried there.

Mr. Scott Russell.

Debate on naval war game.

Mr. Scott Russell.

I want to rid your minds of the supposition that the armour in the bow of the ship is of the least use to you in giving the ship the strength necessary to make her a better ship in the case of ramming. I am one of the few people who have taken the trouble to run down vessels, to see whether my work would or would not stand, and I assure you all the armour you have hitherto put on a ship gives weakness in that case instead of strength. You go bang at your ship; what do you find? You find the plates tilt out, and when you hit upon them at a place which slightly dinges them in, the dinging in of the armour at that point tips it out at all the other points, and the armour tumbles down. I want you not to take away a single plate from the central battery of your ship and stick it on the bow, in the belief that your bow will be one bit the stronger for the purpose of ramming. I want you to make your bow strong, but do not do it by armour, do it by something quite different. I am an old advocate for end-on fire, and I remain so; but now in your large armour-clad war ships, I am an advocate for broadside fire, because I am satisfied that the end-on work is chiefly to be done by ramming, and that it is only where the ram is not used that your guns are wanted, and then you ought to have them all on the broadside.

M. Marchal.

M. Marchal.

Revue Maritime, January, 1878. 'Tableau et classement des Marines Militaires.'

In what proportion should the symbols representing the comparative power of the armament be distributed as between the number, the calibre, and the ranges of the guns? This is what we have to determine from an examination of the incidents of the engagement between ironclads, so far as we may feel authorised to draw conclusions from the exhaustive study of the battle of Lissa, and from the experiences obtained from the sham fight by the squadron of evolutions under the command of Vice-Admiral Touchard on August 5, 1874.

At Lissa, Admiral Persano began to fire without effect when he was scarcely within range. It is probable that in future we shall be rather inclined to follow the example of Admiral Tegethoff, who never fired except when within close range. It is laid down by Admiral Bourgois in the *Manœuvres des Combats sur Mer*, that in order to use artillery with precision the fire must be reserved for a volley from the bow guns at the instant before the attempt to ram, and for another volley while the ships are passing broadside to broadside. . . .

It must not be forgotten that the principal advantage anticipated

M. Marchal.

...a wide arc of training, is that of being able to fire at the same ...e in several opposite directions, and that in some cases there is ... hesitation to diminish the arc of training, in order to have a ...re powerful fire in directions where it is important that the guns ...ould be used with the greatest effect, as for example in the ...nflexible,' where the arc of training might have been more extended ...ith superstructures of the same size, if the turrets had not been ...laced diagonally on the citadel. Mr. Scott Russell, taking up an ...lea which we do not think altogether novel, has recently asked that ...he guns should be mounted without any means of lateral training; ... proposition which is capable of being defended now that the target being constantly in motion will bring itself in front of the guns. In the sham fight of August 5, 1872, it was clearly shown that the guns on the broadside, all of which were fired through ordinary ports pierced in the side of a ship, must be laid beforehand and fired at the moment that the enemy was passing in front of the port. This was owing to the fact that the lateral training of the broadside guns is so limited that they can only be directed at an enemy on the beam; and the distance was too small to allow of the gun being laid with sufficient rapidity on an enemy steaming past at high speed. This case alone suffices to show the superiority of the indented ports in the angles of the batteries, which allow of two shots being fired during the attempt to ram; the one at the enemy when in the end-on position, and the other when he is passing on the beam.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION VI.

THE RAM AS A NAVAL WEAPON.

BRITISH AUTHORITIES.

Admiral Warden.

Admiral Warden.

Trials of the Channel Fleet in 1868. Parliamentary Paper, 1868, No. 500.

The subject of 'ramming' I approach with great diffidence.

It is one which exists principally in the region of speculation. I am not one of those who think that in the next naval war ramming will rank before artillery as a mode of attack; but I believe firmly that it will play a very important and formidable part in all future engagements.

Possibly some naval actions will be decided by the independent and energetic action of some individual captain seizing the fortunate moment and the right opportunity for running his enemy down at a high speed.

It is as clear as anything can be that so long as a ship has good way on her, and a good command of steam to increase her speed at pleasure, that ship cannot be what is called 'rammed'; she cannot even be struck to any purpose so long as she has room and is properly handled.

The use of ships as rams, it appears to me, will only be called into play after an action has commenced, when ships, of necessity, are reduced to a low rate of speed, probably their lowest. I therefore apprehend that it would be consistent with prudence and good tactics always, when going into action, to hold in reserve a portion of the squadron or fleet (and that whether the force was large or small, whether the enemy were numerically superior or otherwise) to act as rams; and when the action had commenced, and noise and smoke and fire were doing their work, the reserve to be brought into play to act independently, as circumstances might require.

For this purpose ships must be made capable of playing their part, and strengthened on purpose to perform such a duty; and the form of bow which I believe best calculated to deal the hardest blow, and carry with it the greatest amount of destruction, is the straight upright stem of the 'Achilles,' or the slightly curved one of the

'Minotaur,' rather than the projecting prow of the 'Bellerophon,' and others of a similar form. The result of the experience gained when the 'Amazon' rammed a small steamer in the Channel is not encouraging. *Admiral Warden.*

I believe also on this subject, as well as on very many others connected with naval warfare, that the first great action which takes place at sea between ironclad squadrons or fleets will dissipate and cast to the winds many of our preconceived opinions and theories, disturb many of our prejudices, and throw an entirely new light on the whole subject.

Captain Vansittart, R.N.

Captain Vansittart, R.N.

1868.

Unfortunately the late cruise has been altogether in fine weather and smooth water, and we have had no form of vessel other than broadside ships on which to remark; but I should recommend the adoption of a certain number of turret vessels capable of mounting far heavier guns than any known in the late squadron, besides some few rams, purely as rams; not with the idea of substituting turrets for broadsides, but with the view of strengthening England's fleets; in short, as regards the form, armour-plating, rig, and armament of Her Majesty's war ships, I would adopt the old saying of 'not putting all one's eggs into one basket.'

I have, &c.,

E. W. Vansittart, Captain.

Rear-Admiral Frederick Warden, C.B., &c, &c.,
Commanding Channel Squadron.

Captain Colomb, R.N.

Captain Colomb, R.N.

From a paper, 'On Modern Naval Tactics,' by Captain Colomb, read at the Royal United Service Institution, February 28, 1865.

The serious part of a future naval attack does not appear to be the guns, but the rams.

As a defence against rams would not the knowledge that every ship in an indented line had a torpedo extended from her bows, which required only a gentle rub to call into action, be a wholesome disturber of the nerves of any adventurous ram-captain who might be disposed to try the new weapon?

Captain Colomb, R.N.

'Lessons from Lissa.' United Service Institution, April 29, 1867.

The battle of Lissa is, beyond all bounds, the most important naval occurrence since the great day of Trafalgar.

There were on the Austrian side 7 ironclads, not of first-rate model, with an aggregate burden of 27,200 tons, an aggregate power of 4,750 horses, a broadside of 88 guns, and 2,884 men.

On the Italian side were 9 ironclads, all of new construction; of greater speed and generally of heavier plating than the Austrians; a combined tonnage of 38,500; a power of 6,000 horses; a broadside of 103 guns; and about 4,000 men. . . .

'Thus on the one part,' says the article in the *Revue des Deux Mondes*, which in spite of denial is still attributed to the Prince de Joinville, 'we see the Italian squadron in a thin line, of the depth of a single ship only, drawn out to the length of 5,000 yards, presenting their broadsides to the enemy. On the other the Austrian squadron in a compact mass closed up to a breadth of 1,200 yards, rushing upon the enemy at full speed with the advantage of wind and sea, to pierce him through and through. Such was the opening of the battle. . . .'

On neither side was any important damage done, and the Austrian leading division passed through the Italian line between the third and fourth ships. . . .

It will doubtless occur to you here to require an explanation as to how the Austrian ironclads, bent as they were on running down their opponents, should have actually passed through the line at a point where there were no ships to run down! Again, a very simple and significant reason is at hand—they were returning their enemies' harmless fire by one equally futile, and were in consequence blinded and confused by the smoke of their own guns! . . .

From what happened after the two fleets fell into confusion, until they separated, two incidents only need be drawn forth for remark—the sinking of the 'Rè d'Italia,' and the firing of the 'Palestro.' After several failures, partial rubs, and total misses, one Austrian ship—the 'Ferdinand Max'—sees ahead of her a grey mass, she goes full speed at it and hits it fair. The shock to her does not appear heavy, and does no damage; the huge grey mass, however, surges over 45 deg. The 'Max' backs astern, and looks with somewhat of awful curiosity for the result of her blow. It is not long doubtful. The 'Rè d'Italia' tumbles back again. There is terrible confusion on board, for the water is roaring into her like a cataract. In two or three minutes the victim plunges heavily down, and leaves nothing to tell of her whereabouts but a few shrieking, struggling remnants of her ill-fated crew of 600 men. Four hundred souls, they say,

went with her to the bottom. Now, what lesson are we to draw here? Simply that there is an end of the danger previously supposed to be incurred by the ram in striking. The 'Max' ran her prow completely into the 'Rè d'Italia' without any evil results whatever. There was no displacement or straining of her engines, nothing in short as a set-off against the terrible damage she inflicted. The power of the new weapon was conclusively proved, and it is henceforth impossible to doubt its practical value. . . .

Captain Colomb, R.N.

The rise of the ram in foreign estimation is one of the most remarkable features of the age. Dating from the first utterances of our gallant Admiral of the Fleet, Sir George Sartorius, the ram has carried all navies by storm, and, so far as I can gather, except in Russia, without enquiry. When I read my paper on Modern Naval Tactics, here, in the year 1865, and acknowledged myself a complete convert to Sir George Sartorius's views, English naval opinion was incredulous. Admiral Boutakov had written ably on naval tactics, but had nowhere expressed a conviction that the ram governed the tactics of the future, although an enquirer so acute and unprejudiced could not avoid allusion to its growing importance. In France, a system of tactics based wholly on the supposed unrivalled empire of the gun existed, and there was only the faintest glimmer of an idea that the old line of battle was about to fall from its high estate.

Now look at the change. Admiral Boutakov has worked at the ram question to an extent unattempted by us; and Russia has drawn up her scheme of naval evolutions on the avowed principle that the ram is the only weapon of value against a fleet. France has pushed her old system of evolutions into the background, in the firm belief that the ram, and the ram only, need be feared at sea.

I held the ram to be the effective weapon in a single-ship action, the gun being subordinate. . . .

From Part II. of paper, on Attacks and Defence of Fleets, United Service Institution, January 15, 1872.

I now arrive at a point on which there are not, and cannot be any data, but which universal assent has established as a fact. I allude to the general understanding that whatever formations may be in future assumed by two hostile fleets in action, the ships composing them will always be end-on, and never broadside-on to the enemy. Some explanation is required to show how I look on it.

Very many officers hold that I am wrong in believing that two ships will seldom, or never, meet stem to stem. But I may note that the Russian gunboats never met stem to stem in their experiments; and I may express my firm belief that one or other ship will

Captain Colomb, R.N.

in such a case swerve at the last moment, and pass broadside to broadside without any result from either ram.

The instinct of the naval world has led it to contemplate the end-on position for hostile fleets, not as the best means of attacking with rams, but as the best means of frustrating an attack of rams.

I conclude that the ram dominates and prescribes the formation which is so good a defence against it, that the ram is not the chief weapon in fleet actions.

Sir George Sartorius.

Sir George Sartorius.

On Captain Colomb's paper on the Attack and Defence of Fleets, April 3, 1871.

Since 1855 and 1856 my attention was more particularly drawn to this mode of attack. Without entering into detail, I would simply enumerate the conditions and circumstances under which the ram can be of the greatest service, and show its power and greatest effect over every other class of vessel. I will suppose a squadron of eighteen or twenty of the finest vessels that can be got, whether from Russia, France, or England; let there be one ram without a gun, without any armour-plating, but very rapid and very handy, with much more speed, of course, than any of the vessels that she is going to attack; that this vessel has coal on board which will not emit smoke, when she accompanies this large fleet. By her superior speed she can always avoid an action when it is convenient to her, and she can make her attack when it pleases her. Granting me those two points, she accompanies this squadron, say, for instance, of twenty vessels. The night is dark; the ram carries a kind of jury mast, which she lowers down; she is low in the water; she sees every one of the larger vessels that she is accompanying by their high hulls, tall masts, and funnels; she runs down at the rate of ten or twelve knots upon any one of the vessels that she has fixed upon. I will now ask any sailor: here is a ram running down at night on the vessel that she is going to attack; she makes use of a fuel that emits no smoke; she has lowered down her masts; she is not seen until almost the very moment when the look-out man calls out, 'The enemy is upon us,' which can be but a very few seconds; how is it possible for any of these large vessels, particularly large broadside ships, by any action of the helm to avoid the ram in so short a time? Even if the vessel attacked is able to fire two or three guns, a vessel at night with a narrow bow presented to the broadside ship she is going to attack, how is she to be seen? She is more likely to be felt before she is seen. What is the chance of her being hit? How can guns be fired with any chance of hitting this ram before the latter gave the blow? It is impossible she can

fail in doing that, because there is nothing to disturb her; she fires no gun; there is no smoke to confuse her or bother her; she gives her blow, and the blow that is given with the force of *sixty* or *seventy* thousand tons, what vessel can resist that blow? Mr. Reed, who was one of my first opponents in 1855 and 1856, in his pamphlet admits that there has been nothing invented by human genius that has the power of the ram for naval purposes. I admit that the turret will be a more formidable enemy to the ram than broadside vessels. But at night the turret vessel has no time to fire with any chance of success. Then, again, suppose Spithead full of ships, as it was at the review, what is to prevent a ram coming in at night into Spithead, or at daybreak, and running through the ships at anchor, hitting away right and left? What chance is there of a battery striking her when she is among the shipping? What battery can fire upon the ram without striking more friends than enemies? With regard to Captain Dawson's observations about the torpedo, I think the ram can be a torpedo-vessel as well. *Sir George Sartorius.*

When steam was first used as a motive power for shipping, it was often debated amongst many naval officers of the day the great advantage it held out, amongst many others, for recurring to the ancient mode of running into the enemy and sinking him by the shock. But it soon became evident, that not only the blow could easily be evaded, but that the ship giving the blow could be helplessly cut up by the raking broadsides of its enemy when making the attempt. **The ram used simply as a projectile, without armour plating or artillery.**

My attention was subsequently attracted to the fact, that in the very great majority of cases of collisions between steamers so frequently occurring, the ship giving the stem seldom suffered in her hull and never in her engine.

When the clumsy slow sail and steam shot-proof battery came out to the Crimea, and gave good proofs of her capabilities in battle, then, recollecting my former reflections on using the stem, it at once struck me how easy and practicable it would be to construct a vessel invulnerable, and consequently almost incombustible, of great strength and solidity for running down ships, and very swift; that such a vessel could destroy every vessel of the existing Navy it attacked without the aid of a gun; that a few heavy guns for shot and shell might make her of more general use; that this class of vessel must entirely revolutionise the theory and practice of naval warfare and naval construction as heretofore practised, and render useless the then navies of the world. I stated these views to Sir Charles Wood

Sir George Sartorius.

and to the French Minister in London, and pointed out moreover that the Russians would have ample time during the winter cessation of hostilities in the Baltic to extemporise some craft of this description, and when the allied fleets returned for the spring campaign effect a wholesale destruction amongst both fleets by the prow and by incendiary projectiles and shot and shell. The 'Merrimac' established a little later to the letter the truth and practicability of my warnings.

Although the theory I advocated, and my views and suggestions for meeting the great change taking place, were received with no favour, yet the old Navy with its magnificent ships has passed away like a dream. A far more destructive 'projectile' than the heaviest gun could throw, and capable of unlimited extension for naval warfare against shipping, has now taken its legitimate place. This projectile must make all the new creations of ironclads, intended to replace the ships of the past, follow the fate of their predecessors. I will not enter now into any observations on the great inherent and irremediable defects of the ironclads now so universally felt amongst naval men, as unfitting them for encountering the dangers and difficulties, and responding to the varied requirements of naval warfare in summer and winter on coast and on the ocean. It is sufficient for me to show that, whether in harbour or at sea, whether single or in fleets, they cannot contend against the ram projectile, even without a gun and without protection of any kind but what depends upon their speed, momentum, and handiness.

The feats of the 'Merrimac' in the American war, and the recent terrible fact of the almost instantaneous sinking of the 4,000-ton ironclad 'Rè d'Italia' at the battle of Lissa, established beyond a doubt the destructive superiority of the prow over that of artillery in naval combat; yet the idea still clings to the minds of some able naval officers that the efficiency of the ram is nevertheless dependent upon artillery, requires armour protection, and is inferior to the gun in practicability and importance, and that its blow can be deadened or avoided. I am prepared to show that no such objections have any substantial foundation, and I trust to clearly prove that no class of sea-going vessels, armour-plated or otherwise, could contest the mastery of the ocean with the ram projectile even without guns or shot protection, or be safe from its attacks in their own harbours. I do not for a moment suppose that the ram as a war engine will be infallible. Perfect impunity in warfare cannot be calculated upon, but every element of success is in its favour.

The desideratum of the day is to obtain a safe and manageable

Sir George Sartorius.

gun, capable of throwing a projectile with sufficient force and momentum to smash through any thickness of protection with which a vessel can possibly float.

In searching for such a projectile, we have omitted to recognise that we really possess in the ram one of an unlimited power, when used against shipping. It is more easy to manage, the chances of failure rare, and, unlike the gun projectile, which strikes only what is in its direct line of fire, the ram projectile unerringly follows the object aimed at through every sinuosity of movement.[1]

At the battle of Lissa, in eight hours' heavy firing from about forty vessels only some 250 men were killed and wounded. 'One touch' of the Austrian ram sunk the largest vessel in either fleet, the armour-plated 'Rè d'Italia,' with her crew of 600 men, and left the ram uninjured, ready for her next enemy.

In reviewing the results of the circumstances of that battle, it struck me that in acting against ironclads of the day, armour-plating and guns could be advantageously dispensed with.

Perhaps it may appear at first sight exceedingly improbable that such a ram could not be at once destroyed by the numerous and heavy guns of its armour-plated enemies, but permit me to call their Lordships' attention to the following facts, which will show the all but impunity with which the ram can act against such antagonists, assuming always that it is possessed of a marked superiority in speed and handiness.

Every artillery officer, soldier or sailor, knows the difficulty of striking an object in swift motion, even from a fixed gun, and how this difficulty is increased when both gun and object fired at are in rapid and eccentric motion, and how very much more that difficulty is increased when the gun is to be fired from a vessel rolling and pitching, with heavy seas going over her and into the portholes at each attempt to fire, and when a long interval must necessarily elapse under such circumstances between each fire.

Numerous instances, well known to every naval officer, could be adduced in proof of this difficulty of hitting a moving object, such, for instance, as in the case of the blockade runners in the late

[1] Admiral Goldsborough, one of the most distinguished officers of the United States Navy, in an official report to his Government, calculates that the blow from the prow of the American ram frigate 'Dictator,' of 4,000 tons, moving with a speed of fifteen knots, would be equal to that of an iron ball, 10 ft. 2¾ in., moving with a velocity of 1,000 feet in a second. Against such a pressure, even if the blow of the ram were given at an angle of 45 deg., tillers and every kind of steering gear would burst or snap off like a rotten stick, and the stern-plates be forced in.

Sir George Sartorius. American war. These vessels had to pass through the blockading squadron sometimes in open daylight, yet very few were captured through the agency of *guns alone*, the greater portion failing through the difficulties and intricacies of the navigation. . . .

I think that for more *general service*, a larger class of rams may be built to carry guns of the heaviest possible calibre by making the ship itself the gun-carriage. The horizontal training would be given by the twin screws or turbine power, and powerful buffer springs or other elastic media could be arranged to soften the recoil and push back the gun in its place. No other men need be exposed than those absolutely necessary for loading the gun. The weight and complications of gun-carriages would be saved. It is now generally admitted that no efficient protection can be obtained for *sea-going useful* vessels of war, and that insufficient protection is worse than no protection. I think therefore it would be much safer (and other more important qualities would be obtained in compensation) to give up all further attempts at protection—to fight the guns *en barbette*—make removable every possible object that could cause a shot to splinter or a shell to explode, and merely have shifting mantelets against the rifle. . . .

If the steam ram is to become the predominating form, that and the torpedo become the most available, safest, and best protection for all harbours, military or mercantile. As these vessels would always be the first called upon when an enemy's cruiser appeared, they ought to possess, with extreme speed, a certain amount of iron protection for gun and engine to guard against even a chance shot. Otherwise in a stern chase, with head to wind and a strong breeze, the stern guns of the chased have much the advantage over the bow guns of the chaser, which under such circumstances would have heavy seas dashing over her guns. . . .

My reasons for refusing guns to the unarmed ram is that there should be no possible cause or temptation to distract the attention of the commander from the ram power. It was the gun and smoke from the Austrian rams that made them lose their best chance, when they *ran between the Italian ships, instead of into them*, when the latter were firing their broadsides. I gain, what is of more importance to these vessels in compensation for the gun, more speed and handiness. . . .

The unarmoured ram should be fitted to use the torpedo, whenever occasion permitted. It ought to have shifting outriggers on bow and stern for running out to support a light net of iron, or strong iron wire, or even of rope. It should sink and be maintained in a vertical

position down nearly to the ram's draught of water, so as to sweep up or cause the premature explosion of torpedoes laid down in an enemy's harbour. The ordinary speed of the ram should not be less than 15 knots, and should be capable of rising to 19 or 20. *Sir George Sartorius.*

Although when steamers have run into each other, or against rocks at full speed, there is no instance of the engines being dislocated or inutilised *by the shock*, but quite otherwise, yet as the experiment of these vessels is in its infancy I think it would be prudent for the unarmed ram to be prepared with every mechanical contrivance, to make the fore-and-aft strength of the hull equal to an almost tenacious solid cube. At the same time the engine also should have some additional security. I may however observe that what I have always maintained has been now abundantly verified by facts. Any person down the hold of the gun-room of either ship would hardly have known when the blow was given and received. The ship struck yields something in the water, and her side is quickly, but progressively forced in. It is not the suddenly stopped blow of a small weight against a heavy unyielding surface, but it is a vast momentum with a form fitted for penetration, entering into a yielding and receding substance.

To decrease as much as possible the surface exposed to the eye or fire of the enemy, and also, if required, add to the momentum of the ram, when the weather admitted, arrangements should be made to let in water for sinking the vessel, almost to the water's edge, when required.

The motive power should be the double screw, or turbine principle. The latter would be preferable if it could ensure the required speed, as then the using indiscriminately both ends as striking ends becomes much simplified, and the water intentionally let in, or by leakage, could be almost instantaneously pumped out.

Rear-Admiral Scott.

THE RAM.

This has been aptly termed 'the naval bayonet,' and is a weapon which, if handled with skill and pluck, will prove invincible. Its special fitness for British sailors was referred to in my last lecture, and the Chief of the Naval Constructive Department of the nation which used it with such effect off Lissa says of this weapon, when speaking in regard to the reconstruction of three vessels of the Austrian *Rear-Admiral Scott.*

Rear-Admiral Scott.

Paper on the Maritime Defence of England. United Service Institution, June, 1876.

Navy at the cost of one ironclad—that we, as the result of this cheap conversion, 'now possess three rams, the most dangerous and secure weapons, I consider, and compared with which the action and effect of the aggressive torpedo is, in my opinion, doubtful and insecure, and may easily endanger the ships of its own fleet.'

Such then is Herr Romako's opinion of the relative values of the ram, and of the fish-torpedo which the Austrians were the first to purchase and experiment with. . . .

The nerve, coolness, and resolution of our seamen are proverbial among nations, and the ram is a weapon which could only be used with advantage where pluck and coolness go hand in hand, and where the resolution is well supported by the skill to direct the blow.

Admiral Randolph.

SQUADRONS.

Admiral Randolph.

End-on fire.

It has been observed that hostile squadrons or fleets will have to be dealt with very differently from formerly; not only will they be attacked in situations where they could not have been reached before the days of steam, but when met at sea an entirely different tactic must be adopted.

The end aimed at will be the same, but almost every means will be different.

Breaking the line, the vaunted triumphant manœuvre of Rodney, which formerly might be supposed to throw the lee portion of the ruptured mass out of the fight for the day, will now be in itself good for nothing. The power to rake your enemy is shorn of its former extreme value; and even the object of manœuvring has entirely changed, inasmuch as it was formerly to get your broadside to bear at most advantage, whereas I submit that the object of ironclads, against whom artillery is comparatively so weak, must be to ram. If this be so, it appears to me to necessitate a tactic different from that formerly and still in use.

Captain the Hon. E. R. Fremantle, R.N., C.B., A.D.C.

Captain the Hon. E. R. Fremantle, R.N., C.B.

If we study the French writers, we shall see that in the scheme of tactics the ram is the effective, if not the only, weapon; guns are ignored till after the first collision of the two fleets, which is assumed

to take place in line abreast, for it is argued that any other formation exposes the leading ship to be rammed by more than one of the enemy. . . .

Captain the Hon. E. R. Fremantle, R.N., C.B.

Naval Prize Essay, 1880. Royal United Service Institution.

The advantages of boldly pursuing ramming tactics are well summed up in the pregnant words of Admiral Randolph :—

'A captain who makes this form of attack on a single ship his main object makes the best defence against it, and woe betide the artillerist who, by losing sight of the danger, even for the sake of all the 81-ton guns he may carry, gives an adroit and resolute ram his desired opportunity:' to which we may add, *audaces fortuna favet.*

Rear-Admiral Sir Edmund J. Commerell, K.C.B.

Rear-Admiral Sir Edmund J. Commerell, K.C.B.

Discussion on Mr. J. Scott Russell's paper. United Service Institution, June 1, 1877.

If Captain Bridge was present to-day, I would say to him that if the enemy had on either quarter two Harvey towing torpedoes, four or five Whitehead torpedoes on each broadside, one or two spar-torpedoes on each bow, and if the hostile ironclad was so armed in addition to her guns and to her ram, and met another ironclad similarly prepared for action, the ram would probably not be brought into action at all, and the battle would be decided by artillery or torpedoes. Then, with regard to the ram, there is a very wholesome respect for the ram in the form now used in the British Navy. It has had the honour of sending one of Her Majesty's ships to the bottom, and has nearly sent several others to the same destination! The highly effective character of the ram as at present shaped will account for what Mr. Scott Russell saw at Portsmouth, namely a sheathe to protect British ships from destruction by British rams. But there is one point with reference to rams, on which I have a strong opinion that we are going on a wrong track. If only one-third of the ships of the British Navy are to be furnished with rams, which third ought it to be? My impression is that it ought to be the smaller vessels. Pit a short gunboat like the 'Ready' against a long ship like the 'Northumberland,' and let both stop firing and try ramming. Which of the two vessels would be more likely to ram the other? Why, the short 'Ready' gunboat ought to sink the long 'Northumberland,' being much the handiest vessel. If that be so, then, in my judgment, all the small ships of the Navy should be armed with rams. I see, with some little regret, a very great friend of the Navy, a very celebrated yachtsman, advocating our fitting out gunless rams. My experience of exceptional vessels is that they are sure to be in the wrong place at the right time. Gunless rams will be sent up

Rear-Admiral Sir Edmund J. Commerell, K.C.B.

the Baltic to attack a fleet, and instead of ships they will have stone walls to attack; what then will be the use of these gunless rams? What again would be the use of gunless rams when attacked by gunboats who shelter themselves from such attacks in shallow water? What would be the use of gunless rams in attacking vessels protected by torpedoes? What superiority would a gunless ram have when contending against a fully gunned ram? I was surprised that so intelligent a friend of the Navy, an artillerist too, should have given way to the torpedo scare, so far as to have been frightened out of his guns. All these arms are necessary, and artillery most of all.

Lieutenant Eardley Wilmot, R.N.

Lieutenant Eardley Wilmot, R.N.

Essay on Great Britain's Maritime Power. United Service Institution, vol. xxii.

As for the reasons laid down, I would not give torpedoes undue pre-eminence over guns, so also I would not consider it desirable to build vessels for ramming alone. The ram is an important weapon within the limits of its range, but many conditions come into play before its successful operation can be assured. Such would need, in a vessel attempting ramming only—

1. Great speed.
2. Handiness in movement.
3. Skill and nerve of a high order.
4. Incapacity on the part of the enemy.

Furthermore, the effect of a blow from a ram will be less than of a torpedo explosion, and I am inclined to believe the idea of the former is much exaggerated. It is probable that an efficient watertight compartment system will prevent any ship being sunk in this manner.

Admiral Hobart.

Admiral Hobart.

North American Review.

There are many naval officers who trust entirely to destroy the enemy by ramming. I can only say to them, 'Your idea is good in theory, but remember that two can play at that game.'

By all means use your ram when an enemy is crippled; in fact, I think that all fleets should be attended upon by ram-vessels, who should lie by until one of the enemy's ships is in difficulty, and then rush at the injured ship with their ram. Guns in such vessels are almost superfluous.

'Edinburgh Review.'

Through the darkness of the future we may perhaps discern the faint glimmer of some new principles of tactics. We have for ever bidden farewell to that old system in which one side waited patiently to receive the attack of the other. A constant state of motion will henceforth be indispensable to ships when engaged. Whether the formation for attack in line abreast, in échelon, in detached triangular groups, or in line-ahead, be the one to be generally adopted, is still debated by naval officers—each method has its advocates. But whichever finds most favour, there is little doubt that the attack itself, indeed that the whole combat, will consist of a series of rapid penetrations of the enemy's line, not unlike the *diecplus* of the Greeks. Each side will be equally an attacking party. The movements of two hostile fleets in collision will probably bear no inconsiderable resemblance to the dashing charges of heavy cavalry in the earlier wars of this century; and our old cavalry tactics may furnish useful hints to the new school of naval evolutions. The ships on either side will be intently occupied in endeavouring to make use of, and avoid, the ramming attack. Skill in handling ships will be more than ever important; and if the torpedo-system of Captain Harvey be perfected, there seems more than a probability that the gun will re-assert its claim to the position from which the ram had appeared to extrude it. Speed and precision of movement will henceforth be the great desiderata in manœuvring fleets.

Edinburgh Review. 'Past and Future of Naval Tactics.' October, 1872.

AMERICAN AUTHORITIES.

Secretary of the United States Navy.

The monitor class of vessels has, for us, special and valuable uses in conjunction with other forces. The torpedo schools give our officers the instruction necessary to utilise whatever there is in this most efficient arm of attack and defence; and I would add to the force a new element, the marine ram, which promises, when constructed upon scientific principles, in forms of special strength for its particular and appropriate service, to be a weapon of most destructive warfare. The construction of this class of vessels has been carefully considered for several years past by a naval officer of high rank, assisted by able experts, and detailed plans are put at the service of the department

Secretary, United States Navy. Report, 1876.

without cost or charge of any kind. The construction of such a vessel, of the best material and of special strength, would involve an expense of about $350,000, and if successful, as it promises to be, it would add a new element, tending to make our force complete in itself, at once economical and efficient.

With such a force, and with no colonies to defend, I think we may well dispense, for the present at least, with the heavy-armoured and unwieldy ironclads of European nations, and also with the monster cannon necessary to penetrate them. Any vessel which can safely cross the seas to enter our harbours, or to lie upon our shores, will be found vulnerable to cannon of moderate weight and calibre, while the heaviest armour will not protect a ship from the attacks of torpedoes managed by brave and well-instructed officers.

Bureau of Construction and Repair.

The service requires fast, unarmoured, cruising ships, and also one or more powerful rams. With very fast ships we can destroy the commerce of an enemy, and be on equal terms with his ships of like character; while in the event of meeting with powerful, but comparatively slow armoured ships, we could leave them at pleasure. Believing that Congress would not long delay the appropriations needed for vessels of this character, directions have been given to have plans prepared by naval constructors having work in charge, for iron unarmoured cruising vessels of 3,500 tons displacement, and iron rams of 2,000 tons displacement.

Rear-Admiral Goldsborough, U.S.N.

Notwithstanding all that has been done, and the enormous expenditures incurred to secure an invulnerable hull *throughout*, and to guard at the same time against too great a sacrifice of sea qualities, and other essential attributes, but at least an indifferent success has been reached in any quarter, and this has already induced some respectable minds abroad, if not among ourselves, to despair of accomplishing much more. The efficiency or intrinsic worth of an ironclad, intended for the ocean or for coast purposes, is to be estimated according to her strength throughout *every part* of the hull, her sea qualities, the disposition and character of her battery, and the ability of its use in all cases of fighting weather, the efficiency of height of her deck above the water to resist the vaulting efforts of a

spoon-bowed opponent, the substantive protection afforded by her plating; her capacity to move rapidly and turn quickly; her space for requisite accommodations; and (pardon the word) her habitability. . . . Rear-Admiral Goldsborough, U.S.N.

It is very clear that no vessel confined to rational dimensions can support, throughout her exposed parts, more than a very limited thickness of iron plating. . . .

A hull arranged after this fashion, with turret for the battery, is, I conceive, about all that can be done in the way of plating with iron, consistently with all the considerations involved; and even this would be of but poor account unless the other elements of efficiency mentioned above were duly secured.

Among those elements is that of celerity in turning, and as it is a point to which sufficient attention has not been given hitherto, I wish to impress my convictions in regard to it.

Every ironclad, as a matter of course, should be an unexceptionable ram. This, however, cannot be the case unless she can be directed with a great degree of promptness to any desired quarter, or turned with every degree of quickness necessary. But celerity in turning is not to be estimated only by the advantage it gives in offensive movements, for it is also of the greatest consequence in defensive operations, and, as an instance, it confers the power to parry, generally, the intended blow of an antagonist ram, if not to avoid it altogether.

Velocity, involving as it does the capacity of prompt presentation wherever required, of making in effect the vessel herself a terrific projectile, of turning rapidly, and of avoiding hostile demonstrations whenever necessary, is of such primary importance that an insufficiency is to be regarded as fatal to efficiency. . . .

A marked pause must occur in the progress of ordnance before a fixed or definite conclusion can be reached as to the relative immunity obtainable by iron plates. Absolute immunity is out of the question.

The progress of ordnance has already produced the effect of restricting the application of armour in the case of sea-going vessels to the more vitally exposed parts; and it is quite possible that it may finally establish conviction that such plating, for such vessels, is really of no marked consequence. In the meantime the tendency of its effects must be to impress the value of rams, thus reviving a mode of naval warfare which, on a miniature scale, existed long before the invention of gunpowder.

The value of rams at this very moment cannot be over-estimated.

Rear-Admiral Goldsborough, U.S.N.

With a few of them in each of our prominent commercial ports, none scarcely of more than half the displacement or weight of the 'Dictator,' no enemy, I care not how powerful, could blockade those ports successfully; for possessing the great advantage of biding and selecting their own time, they could so manage the delivery of their blows as to annihilate his vessels. Nor could those ports in my judgment be assailed successfully. The protection of harbours now-a-days does not lie in forts. It lies essentially in powerful steam rams, aided when necessary by obstruction in passage-ways.

Rams, intended purely for harbour defence, would be better without than with guns. They themselves are to be the projectiles; or, if you please, they are to be the shot, and the steam is to be the powder; and the effect of both, properly combined, would be absolutely irresistible. Besides, to fit the rams for guns would be to swell the item of cost largely, and thus abridge their multiplication. The essential points to be secured in these rams, each to a degree as consistently with all the rest as practicable, are great strength throughout every part of the hull, not overlooking the bottom by any manner of means, every protection that supportable plating can afford; a high velocity; an ample security of machinery; the utmost rapidity in turning; and a suitable bow. . . .

I have met with no ideas with regard to sea-going ironclads that have impressed me so forcibly as those of Captain Coles, of the British Navy; and I think his system, in the main, is about the best that can be adopted at present. In my humble opinion, he meets the difficulties of the case better than they have yet been met in any other quarter; and he displays throughout his exposition a fertility of resource, a fund of ingenuity, common sense, and professional experience, that confers upon him distinguished credit.

It strikes me that it is inexpedient to construct ironclads to perform only a particular service, except mere rams, unprovided with guns, for harbour defence, and also vessels for interior river operations, in a country like this, in case of intestine difficulty. They should, I think, be made to answer as many naval purposes as possible, and their cost alone, independently of other considerations, is enough to determine the question. All, therefore, barring the exceptions just mentioned, should, it seems to me, possess the attribute of seaworthiness; by which I mean the capacity of being sailed or steamed anywhere over the ocean, and of keeping the sea as long as a vessel of the class would probably be called upon to do. Without this attribute their sphere of usefulness must inevitably be but local and contracted.

Rear-Admiral Ammen, U.S.N.

I venture the opinion that the time is not distant when the marine ram will take the place of the enormously expensive armour-plated gun-bearing ships of to-day. *Rear-Admiral Ammen, U.S.N.* *United Service,* April, 1879. Philadelphia.

I believe much the larger part of the educated Navy men of all grades are in accord to divide our naval vessels into two general classes,—one for coast defence, the other for cruising abroad and serving as schools of instruction for officers and crew. . . . 'The Marine Ram as a Naval Economy.' *The United Service,* April, 1880. Philadelphia.

For coast defence, it was assumed that our reliance should be upon marine rams, torpedo-boats, and floating batteries.

The marine ram, however, should be regarded as the principal element on which dependence is to be placed, and in order to meet requirements should have speed and the power of maintaining it for twenty hours at least, handiness, great strength of construction, and a practical invulnerability to shot. . . .

The ease with which expensive armour-plated gun-bearing vessels have sunk, when endeavouring to avoid each other, suggests the havoc which a fleet of properly-constructed rams would make in a fleet of armour-plated vessels.

Considerations of both economy and efficiency point to the marine ram as the main element in the solution of the problem of coast defence. . . .

The rams would be maintained in war at a much less relative cost because of the small number of the crew required per vessel, four officers and sixteen men being necessary under ordinary conditions, which is about one-fifth part of the number now carried by our smallest three-gun cruisers of four hundred and fifty tons.

When not required for actual service or for practice-vessels, they could be hauled up at convenient points under cover.

Naval Reorganisation, by a Junior Officer.

I do not think it necessary to build vessels to be used only as rams. Any vessel of sufficient weight and speed only needs a ram put on her to make her a good ram. To prove this I would cite the case of the Transatlantic steamer 'Arizona,' recently in collision with an iceberg. In round numbers the weight of her hull and cargo was ten thousand tons. She was going at the rate of sixteen miles per *United Service,* April, 1880. Philadelphia.

Rear-Admiral Ammen, U.S.N.

hour, or twenty-three feet per second. The striking force exerted was therefore tremendous. She was well built for a merchant vessel, and struck square bows-on. The forward part of the vessel was somewhat stove in and injured, but the first watertight bulkhead prevented further damage.

The blow delivered by such a vessel, at so high a speed, would destroy any vessel in the world if fairly struck abeam.

Every vessel of any size in the Navy should be a ram in addition to her other means of attack.

In case of war, iron merchant vessels, if strengthened about the bows, would make effective rams.

Chief Engineer King, U.S.N.

Mr. King, U.S.N. — *European Ships of War*, p. 182. Uncertainty of the ram.

If anyone will carefully read the account of the 'Fatta di Lissa,' he will perceive the extreme difficulty which was experienced by both Austrian and Italian captains in delivering against a ship in motion the fatal and decisive blow. It was not until the rudder of the 'Rè d'Italia' was disabled, that the Austrian ironclad was able to ram her.

FRENCH AUTHORITIES.

Admiral Jurien de la Gravière.

Admiral Jurien de la Gravière. — *La Marine d'Aujourd'hui.*

In fact, if modern projectiles are once more to be dreaded when a normal blow is struck at short range, they remain altogether powerless for the purpose of attacking a retreating enemy. It is by the ram that victory must be won: it is against the ram that precaution must be taken. On the approach of an enemy, the guns of an armoured vessel must be silent. The slight advantage which might be gained by firing with uncertain aim upon a rapidly approaching object would not compensate for the embarrassment caused by the cloud of smoke, by which the ship would be enveloped, at the moment when her safety must depend on the precision and rapidity of her movements.

No absolute rules can be laid down as to the order of battle for an armoured fleet. To change an order of sailing into a formation for battle, the stem must invariably be turned in the direction whence the attack may be expected. This main point being conceded, many more or less ingenious combinations will doubtless be proposed. In practice the result will inevitably be, first an irregular formation and then a *mêlée*.

The naval battles of the past will enable us to some extent to form an idea of those of the future, provided that no new transformations take place in the existing *matériel*. Two hostile armoured fleets approaching each other will reserve their fire. Each vessel will single out an adversary, and endeavour to destroy him by a sudden charge with the ram. This charge will more frequently result in an oblique collision than in a blow at right angles. Oftener still the blow will be avoided altogether, and the broadsides of the two vessels will be exposed to each other at short range. Then it is that the gun will tell, the armour and framework of the ships being exposed to the full effects of a point-blank discharge. *Admiral Julien de la Gravière.*

What will have been the results of this first encounter? At nearly every point the two opposing lines will have been penetrated. By the impetus they have acquired the ships will be quickly separated, and will return to the charge. The fleet which succeeds in wheeling round with the greatest celerity will have an immense advantage, because the stem will threaten the broadsides of the enemy.

Admiral Touchard.

As the ram will be the principal weapon in future naval battles, it would be necessary to present the bow at all times to the enemy, whether for the attack or defence, just as the sword must always be held with its point towards the adversary. A story is told that, one day, hearing of the inefficiency of our guns, one of the most brilliant Admirals of the French Navy replied: 'If our guns are impotent, and we go to war, we will throw them into the sea, and we will charge the enemy with the ram. . . .' *Admiral Touchard.* — *Combat de Lissa.* Paris, November, 1866.

In the case of land battles, a cannonade generally precedes a closer encounter between the contending forces. It will be the same on the sea; and it may be that two squadrons will generally be seen forming in parallel lines in order to commence the engagement with their guns. But on the sea, as on the land, this cannonade will be nothing more than preliminary. The serious and decisive battle will be fought by a charge, ship against ship, as it is on land by a close engagement between battalions of infantry.

Offensive power is the result of several factors—the gun, the ram, and the torpedo—and, in another point of view, it depends on speed and handiness. The power of turning is of cardinal importance for the use of the ram. *La Question du Décuirassement.*

M. Marchal.

M. Marchal.

Revue Maritime, p. 193, January, 1878.

M. Marchal gives an extract from a high French authority to show the great importance of the evolutionary quality in a ship of war :—

'M. le vice-amiral Bourgois, dans ses "Etudes sur les manœuvres des combats sur mer," a mis en lumière le rôle des facultés évolutives par une discussion approfondie, dans laquelle il explique de la façon suivante qu'on serait peu fondé à chercher dans la valeur de la durée de giration la caractéristique de ces facultés : "De ces deux qualités, de tourner vite et de tourner court, qu'on a souvent mises en parallèle, la première dépend de la seconde, c'est-à-dire de l'étendue du cercle décrit, en même temps que de la vitesse de sillage (headway) avec laquelle ce cercle est parcouru. La qualité de tourner dans un cercle de petit diamètre est donc véritablement la qualité prépondérante pour un bâtiment destiné à combattre par le choc." . . .

'Des trois engins d'attaque actuellement connus, le canon, la torpille et l'éperon, on considérera d'abord le dernier, dont la valeur est intimement liée à celle de la mobilité qui vient d'être étudiée. Cette valeur dépend de l'agilité du bâtiment, qui est caractérisée par le minimum auquel peuvent descendre le diamètre et la durée de ses évolutions. C'est ce qu'a exprimé M. l'amiral Bourgois, en disant : "Un bâtiment peut, au moyen de son éperon, triompher de son adversaire s'il tourne en moins de temps que celui-ci, ou s'il décrit un cercle de moindre diamètre, ou enfin et surtout s'il possède ces deux qualités à la fois."'

The large ironclad which, up to the present time, has exhibited the finest steering qualities, is the 'Thunderer,' which is stated to have turned in 4′ 1″ in a circle of 326 yards diameter.

Baron Grivel.

Baron Grivel.

Guerre Maritime, ch. x. p. 225.

The ram, it is certain, will be the weapon of the future. If one of the combatants makes a resolute charge on another, the blow must be parried not with the gun, but by rapid and skilful manœuvring.

Captain de Cuverville.

Captain de Cuverville.

It is generally recognised that in the future the use of the ram will be the main object in view in forming the order of battle. It is not that this mode of attack, which transforms the whole ship into an

immense projectile, is easy and always certain of success. It is not that the ram has become definitely the *ultima ratio* of naval combats; but in view of the possible success of an attack of this nature, no one will willingly expose himself to the terrible disasters which might result from a fatal blow. To present the bow to the enemy will therefore be the best position both for offence and defence. Whether provided or not with the means of penetrating the hull of the adversary and striking him where he is unprotected by armour, the bow is undoubtedly, in the present day, the strong point of the battle ship; and however numerous and powerful the guns may be which are distributed on the broadside, the beam is the weak point.

Captain de Cuverville. — 'Quelques Réflexions sur les Ordres de Bataille.' *Revue Maritime et Coloniale*, December, 1876.

M. Dislère.

Many explanations have been sought of the rapid destruction of the 'Vanguard.' In our view there is but one explanation. Iron-clads cannot resist the ram. It will therefore be the real weapon of the future. It is with a view to secure the effective use of the ram that we ought to design our ships in such a manner as to secure for them a high evolutionary quality.

M. Dislère. — *La Guerre d'Escadre*, ch. vii. p. 169.

Although in defence of ports, coast batteries, fixed torpedoes, and obstructions form an important element of resistance, it must not be forgotten that the true strength of the besieged will consist in the means of active defence, including torpedo-boats, automatic torpedoes, gunboats armed with one heavy gun—resembling floating gun-carriages—ready to disperse before the attack of a more powerful enemy, and finally rams, constructed specially for coast-defence. The latter only come within the scope of our present observations; and without disregarding for a moment the value and importance of the other weapons, we may regard the ram as the basis of defensive strength. The ram may select the moment for action, and penetrating—in most instances under shelter of darkness—the lines of the enemy, may succeed in running the blockade by sheer force. More handy then armoured vessels of high freeboard, possessing a shallower draught of water than the attacking vessels of the coast-defence type, it will be inferior to the latter in speed alone, and this only in case it should be decided to arm the ram with guns—the desirability of which course is in our opinion doubtful. The coast-defence ram should, according to our theory, be able to pursue its course in the

La Marine Cuirassée, ch. v. pp. 116-7.

M. Dislère. face of all obstacles: it should be itself the projectile, or, as Admiral Goldsborough has observed in one of his reports, the vessel should be the bullet, the steam the powder. The combined effect of the weight of the vessel and of her speed should be irresistible, and the ram, reduced to one sole weapon, a formidable stem, relieved from the weight of artillery and from the burden of the armour required to protect it, small, handy, and swift, darting about in all directions in the midst of a blockading and bombarding squadron, impenetrable to the guns of the enemy, escaping the attacks of their rams by means of her high evolutionary qualities—such a vessel should be a most formidable adversary. As yet this type has not been adopted, and all coast-defence vessels in France and elsewhere carry a powerful armament, a plan which, in our opinion, can lead but to one result—the destruction of the unity of purpose which is essential to a successful type of a fighting ship and a tendency to increase the dimensions to a degree which is incompatible with the true *rôle* of a ram.

The sole duty of the ram, whether armed or unarmed, is to fight outside harbours and roadsteads. If it remains under shelter, as did the 'Tennessee' at Mobile, lying in wait to attack any ships that might force a passage up the river, it forms a tempting object of attack to an enterprising enemy. The ram should above all things be agile and incessantly moving, and should possess sufficient sea-going qualities to enable it to leave the shelter of the land in all weathers to attack hostile cruisers.

RUSSIAN AUTHORITIES.

Lieutenant Semechkin.

Lieutenant Semechkin.

Lectures delivered at Cronstadt in 1868.

The ram has only made its appearance within the last few years. Nevertheless there can now be no doubt in the mind of any naval officer that its immense destructive power will give to the ram the first place among the weapons to be employed against an enemy. The method of attack by one squadron against another ought in our judgment to be devised with exclusive reference to the use of the ram. The reason is not far to seek. The blow of the ram, though very difficult to deliver effectively in an engagement between two single ships, becomes much more practicable in the confused evolutions of numerous vessels. The rapid movement of a compact mass

of ironclads against any point of the enemy's order of battle may cause great losses, and may not improbably lead to the destruction of some of his ships. It is difficult to avoid the concentrated and well-directed charge of a mass of ironclads; and it is even more difficult to have sufficient command of nerves, in face of such a headlong rush, carrying with it death and destruction, and to preserve completely the necessary rapidity of judgment and promptitude in the choice of the most effective measures to be adopted for maintaining the defensive. The attack with the ram produces a certain moral impression, which it is difficult accurately to describe. *Lieutenant Semechkin.*

For these reasons, in my opinion, the attack by one squadron against another must be planned with exclusive reference to the use of the ram. These tactics are, in the present day, the surest and the quickest means of gaining a victory.

. . . .

. The defence in an engagement between ships in the line of battle must depend upon manœuvring. Guns cannot be used with effect in such a case. No further illustration need be cited in proof of the accuracy of this conclusion, after the attack by the Austrians at Lissa. No projectiles, whatever be their weight and their penetrative power, are capable of arresting the charge of a mass of ironclads urged forward with an iron indifference to the fire of the enemy. Moreover, the smoke which is inevitably caused by heavy firing will cover the squadron which is acting on the defensive, and will thus deprive it of a full view of the horizon. Without a clear view manœuvring is impossible, and thus those evolutionary qualities on which we have insisted so strongly cannot be used with effect. We seem entitled therefore to say that, for the purposes of defence in an engagement in the line of battle, armaments are even less necessary than they are for the purposes of attack; and that in both cases equally the ram is beyond all question the dominant weapon, as it is the most effective and the most rapid means of striking a decisive blow at an enemy arrayed in order of battle.

'*Moskoi Sbornik.*'

The opinion is now generally held among sea officers, and we adopt it for ourselves without fear of appearing too confident, that in the future in engagements on the open sea, the struggle will be brought to a decisive issue with the ram. Many sea officers accept it as an axiom—and here we share the opinion of the great majority—that manœuvres with the ram will be the foundation of all tactics in *Moskoi Sbornik.* — *Revue Maritime,* March, 1877.

Moskoi Sbornik.

the open sea, and that the facility with which those manœuvres are executed will exercise a decisive influence upon the issue of a battle.

GERMAN OPINIONS.

'*Die Marine.*'

Admiral von Brommy and Captain von Littrow.

Die Marine (edited by Captain von Kronenfels), ch. viii. pp. 262-3. Third edition.

The French began in 1863 to build coast-defence vessels of greater speed, and the other maritime Powers followed, although very slowly, in the same direction. If coast ships are to undertake offensive operations on an enemy's coast, they must have such sea-going and sea-keeping qualities as will enable them to make considerable passages across the seas in safety. They must have good speed. They must be of light draught both in order to get within short range of fortifications on shore, and to escape into shallow waters from the pursuit of ocean-going ships. That these offensive coast ships should be adapted for defensive operations for the protection of their own coasts is an obvious necessity. The French gave the name of *garde-côtes offensives* to the class of vessels, which were specially designed for attacking the coasts of an enemy.

If it is advantageous for a naval Power to wage war on an enemy's coast, it is a not less essential duty of the Navy to protect its own shores and military and commercial harbours from a bombardment which might destroy valuable property, or the means of carrying on war abroad. While coast batteries, obstructions, and fixed torpedoes afford effective means for securing harbours against attacks, it must not be forgotten that the real strength of the besieged consists in moveable defences—that is to say, in automatic torpedo-boats, gunboats carrying one heavy gun, in light vessels or skirmishers, designed to rush to the attack in large numbers, supported by the heavier vessels, and finally in rams for coast-defence. Without in any way questioning the value of the smaller instruments of war, we must nevertheless regard the armoured rams as of primary importance in a general system of coast defence. They are free to choose their moment of action, and may often, under cover of night, steal their way through a hostile fleet, and break a close blockade. Handier too than the sea-going ships of high freeboard, drawing less water than the offensive coast vessels which could be sent forth against them, these vessels are inferior only in point of speed, and this inferiority would only occur in the improbable contingency of its being thought necessary to arm these vessels with guns. The ram for

coast defence should under no consideration be diverted from its own especial aim. To use the words of Admiral Goldsborough, the ship should be the projectile, the steam the gunpowder. A well-directed blow from a ram moving at high speed must be fatal, and rams, if relieved from the weight of the gun, and the armour to protect it, can be small, handy, and swift. Rushing through the enemy's blockading squadrons in every direction, protected against projectiles by its armour, and avoiding the ram of larger ships by superior agility, such a vessel must prove a formidable assailant. Up to the present time no attempt has been made to produce the vessel thus described, and all the coast vessels hitherto constructed carry a heavy armament, which leads to one result only; namely, that unity of purpose is prevented, and the dimensions are of necessity increased to those of a sea-going ship, a condition which is incompatible with the distinctive qualities required in a ram.

Admiral von Bromny and Captain von Littrow.

Captain Werner.

Artillery is no longer of the first importance in naval war. Victory will belong to the greater number of rams. All modern tactics must be framed mainly with the view to the use of the ram.

Captain Werner. — Lectures delivered at Wilhelmshafen.

'*Marine-Verordnungs-Blatt.*'

In an article on the German Navy, which appeared in the *Beiheft zum Marine-Verordnungs-Blatt*, and of which an analysis is given in the *Revue Maritime* of November, 1874, some very interesting information is given as to the constitution of the German fleet.

Beiheft zum Marine-Verordnungs-Blatt, 1874.

In the opinion of the author, the armament of the ship of the line should consist of the gun, the ram, and the torpedo. He is content with a speed of 12 knots at the measured mile.

If two hostile fleets, equal in strength, were to meet, and their commander should decide to engage, an advantage in speed of one or two knots would be of small importance. For the great majority of fighting vessels extreme speed costs so much that it is an almost illusory advantage.

Convinced that guns are almost useless, in consequence of their limited number when of large calibre, and also having regard to the requisite thickness of armour, and the dangers arising from torpedoes, the writer considers that the victory will be decided by the ram.

The 'König Wilhelm' type does not meet with the approval of

Captain Werner. the writer. Considering that the principal weapon of naval warfare is the ram, he regards the use of that weapon in vessels of this class as rather detrimental than useful. He is of opinion that it is difficult to manœuvre very large ironclads, and that, at the most, such vessels would only stand an equal chance in an encounter with a ram, powerfully armoured, armed with guns of a more manageable calibre, and costing not more than one-third of the expenditure incurred in building a ship of the 'König Wilhelm' class. He endeavours even to prove that a squadron of rams of the type indicated, with a speed of 9½ knots, might engage with advantage an English squadron, capable of steaming 11 knots. He admits that all conceptions of imaginary naval combats have a certain *doctrinaire* character, which deprives them of almost all their value; and he has only one decided conviction, viz. that there would be an immense advantage in diminishing the enormous speed of ships of the line, in order to increase their number and fighting qualities—that is to say, their offensive and defensive powers, facility for manœuvring, and light draught of water. 'Let us not forget,' he says, 'that the cost of a ship that will steam 14 knots must be at least 20 per cent. greater than that of a ship that will steam 12 knots.'

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION VII.

TORPEDOES AND TORPEDO VESSELS.

TORPEDOES.

ENGLISH AUTHORITIES.

Mr. John Donaldson.

Mr. John Donaldson.

From a paper on 'The Thornycroft Torpedo Vessels,' Royal United Service Institution, May 11, 1877.

I think it may be very safely asserted that numbers are only useful in war when their force can be brought to bear on the enemy; and I am quite certain that any number of ordinary 8-knot steam launches, fitted with outrigger torpedoes, might just as well be away on the China station as anywhere in the neighbourhood of an enemy's ironclad, capable of doing 12 knots.

All the ironclad would have to do would be to keep running at a little slower speed than her liliputian foes, and sink them in detail as they came within range.

On the other hand, take the case of the same ironclad appearing off one of our ports defended by a fleet of 18-knot torpedo-boats.

Nothing would require to be done till she came in sufficiently close to use her guns—say three miles at the outside—when, if half a dozen or a dozen 18-knot torpedo vessels were launched against her, they would be alongside in half an hour from the time of their starting, even if the ironclad got away at once.

If the torpedo vessels were armed with the Whitehead torpedo, it would not be necessary for them to go close alongside, and so they would be less easily hit; but the probability of hitting objects running at even the slow speed of six knots per hour, or ten feet per second, relatively to the ironclad is very slight indeed.

Last year at Wimbledon there were 5,000 shots fired at the running-deer—a target moving at the rate of six feet per second, and out of these shots, fired from a fixed platform, by men who almost make a business of shooting—only one in ten hit the bull's-eye at 110 yards; while if the target was stationary, nine shots out of ten could always be depended upon as being bull's-eyes.

I believe the best defence against attack from these torpedo-boats is to have other and similar boats steaming round the vessel to be protected, ready to ram or otherwise destroy the attacking boats. *Mr. John Donaldson.*

Possibly some modification of the hand grenade might be used for this purpose.

Such guard-boats should have as much speed as the attacking boats, and arrangements should be made for hoisting them on deck when they are not required for guard duties. We have designed some small-sized boats for this purpose, but I think the 57-feet type is quite small enough for sea work, and her weight of 7 tons is not a difficult problem to grapple in the way of hoisting.

Rear-Admiral Scott.

The value of our ironclads depends first upon their gun power, and secondly upon the strength of the armour which protects them; but if the gun power be small, the guns not very accurate, or the aiming of the gunners be imperfect, then the large amount of fighting efficiency which we might anticipate from ironclads is neutralised. . . . *Rear-Admiral Scott.* Discussion on Mr. Donaldson's paper.

The operator on board the Thornycroft would have a clear view all round the horizon, and hence would be enabled to discharge the fish in any direction, taking care there was no chance of a friendly ship's crossing its line of advance during more than the $1\frac{1}{2}$ minutes occupied by this torpedo in running 900 yards.

The operator between the decks of an ironclad or other heavy war vessel would have a very limited view, and be only able to train the torpedo on its carriage 15 deg. or 20 deg. each way, and hence would have far less opportunity than the operator on board the Thornycroft of discharging the '*fish*' at the right moment.

The carriage and use of so delicate a weapon on board an ironclad, and costing half a million, with a crew of 400 or 600 men, is of doubtful advantage, for should its air chamber or the 60 or 120 lbs. of guncotton carried in its head be struck by an enemy's shell, the blowing up of its deck, or even still more serious damage, might ensue.

There is a further danger attendant upon the use of a torpedo in a squadron, resulting from the awkward tendency of this missile to take a curved course before it has reached its extreme range of about 1,000 yards; but should the tail or the machinery become damaged, the torpedo might return like a boomerang, and even blow up the

Rear-Admiral Scott.

vessel which fired it. I am pointing out the great care and the very skilful handling required, with the view of indicating that the fish-torpedo can be more advantageously handled by the picked crew of a Thornycroft, than on board one of our larger war vessels, where an accidental blow might cause an explosion.

Commander Hayes.

…mander Hayes.

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Harvey's torpedo will be useful for despatch vessels and merchant steamers, especially when they are manœuvred for the use of this arm alone.

Its disadvantages are, the great amount of practice that is required to use it effectively, the complication of breaks and reels, and the exposure of the men working them to rifle fire, the danger to other ships, and of the tow-line fouling the ship's own screw.

It is doubtful if this torpedo will ever play a prominent part in future naval warfare, its effective range being limited by the length of tow-line that can be used with advantage.

The spar-torpedo will probably be extensively used, as it is cheap and simple in its action, can be easily extemporised, does not require any great skill in handling, and can be kept in hand till the moment when it can be successfully applied. Its use for offensive purposes will probably be confined to sloops, gunboats, and steam launches, the latter especially fitted, but even in this case, the Whitehead would be preferred, if obtainable; a combination of boats would probably be necessary. The spar-torpedo will also be used defensively from the sides of larger ships.

Torpedo-boats attacking a ship at anchor will probably have to oppose two lines of obstructions, and to engage other torpedo and guard-boats; they would also be exposed to a severe fire from rifles, Gatlings, and of grape and case, directed by the aid of the electric light, therefore torpedo-boats should attack in numbers and from different quarters.

Admiral Ryder.

Admiral Ryder.

With regard to the 'relative values of the spar, the Harvey, and the Whitehead torpedo.' As far as I have been able to study the subject I believe the value of the spar-torpedo against a vessel at anchor, unprotected by steam launches, is very great in the hands of plucky men. Its use would have the effect, as it had in the German and French war, of obliging the blockading ships to career up and

down off a blockaded port. The French ships hardly ever remained at anchor for the night before a German port, because they did not care to expose themselves to the attack of fast boats coming out with spar-torpedoes. As to the Harvey and the Whitehead, I feel very doubtful myself as to their being of any great benefit *at sea*. I went on board the 'Thunderer' the other day, and saw 15 magnificent machines in a splendidly illuminated store-room. They were of the most delicate character, and evidently required as much care as the chronometers. I doubt whether in action any of them would do what they were told to do. I think it is very probable they would do what they were not told to do, and that it would be very awkward for some of us they should do, viz. explode prematurely, or mistake friend for foe.

Admiral Ryder. — Discussion on the Prize Naval Essays of 1878. United Service Institution, June 21, 1878.

Commander Lord Charles Beresford, R.N., M.P.

Lord C. Beresford, in calling attention to the increasing power of torpedoes—especially that known as the 'Whitehead torpedo'—said that he had no intention of passing any criticism on the conduct of the Admiralty, but the subject was one of so much importance in naval warfare that it deserved to be thoroughly ventilated. They had all heard of the pamphlet called 'The Battle of Dorking,' the writer of which began by assuming that our fleet had in the first place been disabled and diminished by infernal machines or torpedoes. He was not himself an alarmist. Such an event, although not very probable, was at all events possible, and it could not be denied that the invention of torpedoes had entirely revolutionised the system of naval warfare. There were four torpedoes at present in use in Her Majesty's Navy. First, there was the 'Harvey,' or towing torpedo, which was towed from a derrick-end, or the yard-arm, over or against the enemy, and which exploded on striking. Then there was the 'ground torpedo,' which was a mine torpedo, intended for the defence of harbours or to close the mouth of a canal, or to protect our ships. It exploded by electricity, communicated either from the shore or a ship, or by an enemy striking a floating and partly buoyant body connected with the torpedo. Next there was the 'spar-torpedo,' which was carried in a boat, no matter how small, and which exploded either on touching the side of a vessel or by electricity used by wire from the boat. But by far the most formidable—he might even call it the most awful—weapon of maritime war was the Whitehead torpedo; and it was this which threatened to change the character of naval warfare. It was a body 14 feet

Commander Lord Charles Beresford, R.N., M.P. — House of Commons, March 19, 1877.

mmander Lord Charles eresford, N., M.P.

in length and 16 inches in diameter. It was made in three pieces—the head, which contained a bursting charge of 360 lbs. of guncotton; the balance chamber, which contained a contrivance for setting it so as to remain at any depth it was wished to travel under the water-line; and, lastly, the air chamber, which contained the engines and the compressed air to drive them. Their length was 19 feet, the diameter 18 inches, the appearance being exactly that of a cigar pointed at both ends. The head or foremost end contained the pistol or detonator which exploded the charge. The after-end supported the screws—a right and left-handed screw—which propelled the torpedo and were made of the finest steel. The air chamber was tested to 1,200 lbs. on the square inch, although for service it was only loaded to 800 lbs. The Whitehead torpedo could be made to go at the rate of 20 knots for 1,000 yards, and at any depth that was wished from one foot to 30 feet. It could be set to explode either on striking an object or at any particular distance under 1,000 yards. It could also be set so that if it missed the object aimed at it would go to the bottom and explode on half-cock or come to the top on half-cock so as to be recovered, as it had buoyancy enough just to float on the surface of the water when not in motion. It was fired by what was called an 'impulse tube,' which, out of a frame fitted to a port, discharged the torpedo into the water. It could be fired above the water, but would at once go to the depth it was set for, and then go straight to the object, no matter how fast the ship from which it was discharged was going, or how fast the object aimed at might be sailing or steaming. In fact it could do anything but speak. It was calculated to make a hole on bursting of 70 feet area, and there was no doubt that if one of them hit a ship of any sort or description at present on the water she must at once proceed to the bottom. He would now state what he believed to be the only way of resisting the attack from these infernal machines. He did not think that with ordinary vigilance a ship was likely to be hit with the outrigger or by the Harvey torpedo, as in one case the Gatling gun would destroy the boat, and in the other, in these days of accuracy of artillery fire, the torpedo itself could be destroyed, or the yard or derrick from which it was towed could be accounted for. A Whitehead torpedo was, however, a totally different weapon, and the first intimation you would get of it was by going to the bottom. The torpedo vessel or boat need not be nearer than 1,000 yards, and, premising that the first three shots did not take effect, she should still deliver more, as at night time the vessel's position at that distance was absolutely safe, and the vessel fired against would be positively unaware of the attack until she was

Commander Lord Charles Beresford, R.N., M.P.

blown up. The newly invented electric light from the tops was a great help to the party attacked, but it was his firm belief that if three or four boats of great speed attacked a vessel from different points of the compass, and if they were commanded by smart officers, nothing that she could do would save her from being hit by one or more of them. He had, therefore, in his motion asserted the expediency of adding torpedo-boats and vessels to the fleet without delay. In his opinion—and he was confirmed in it by a number of naval officers whom he had consulted—the only manner in which the Whitehead torpedo was to be combated was by having attached, not only to the fleet, but to each line-of-battle ship or heavy ironclad two or three satellites—namely, very fast schooner-rigged steam vessels, like the steam yachts of the present day, to be fitted as torpedo vessels, and also armed with light guns capable of destroying any vessel of their own description which they might approach, besides being able to destroy any big vessel if they could come near enough to discharge their own Whitehead torpedo. In build they should be as near a yacht as possible, doing not less than 12 knots an hour, but with a lower freeboard, capable of remaining at sea and using sail-power. The low freeboard was desirable, as there was less likelihood of a shot hitting the boat. The idea of protecting a large ironclad with wire nets he did not think at all possible for many reasons. It would reduce the speed of ships of the 'Devastation' class by five or six knots an hour, and the Whitehead torpedo was fitted with sharp 'guides' which would go clean through a half-inch wire netting. A spar torpedo, moreover, could reach over the nets and have full effect upon the vessel. The next point to which he wished to draw attention was equally important—namely, the want of an organised system in connection with our defensive coast torpedoes. The defensive operations were in the hands of about four companies of Royal Engineers. Now, what he would like to see was not only a large body of seamen instructed in the matter, but also all our boatmen, coastguard men, and pilots. Of course, the actual firing of the torpedoes must always be done by trained electricians, but the laying down and taking up of them was essentially a seaman's work. It required a knowledge of the way of handling boats, of tides, soundings, position by bearings, coiling clear, paying out cables, and making bends, &c. For all these things the Navy was particularly qualified, but they must have the practice also. He thought all our squadrons ought to be exercised in this matter, as, in the event of a war, what would now take weeks to accomplish could be done in a few days if the fleet had practice. He would give an

Commander Lord Charles Beresford, R.N., M.P.

instance that was suggested to him the other day. Supposing that while our fleet had been anchored in Besika Bay circumstances had led to a combination of other European nations against us, and that we had found it necessary to hold the entrance of the Dardanelles and also to protect our own shores from invasion—if the fleet had been trained in torpedo work, a few shiploads of ground torpedoes would, by being laid down in a few days, have rendered the passage perfectly impassable, two or three ships would have been left to fire them as occasion offered by electricity, or keep off vessels or boats which would have tried to countermine them, and the rest of the large fleet would have been free to act elsewhere. Tne Germans, the French, and, he believed, the Americans, had begun this work with a system of divided responsibility, but had found it did not answer at all; and now they had all got a regular naval torpedo corps worked by blue-jackets and naval officers. He thought it was most important that we should not only have a regular naval coast defence, but also that our squadrons should be drilled in the work of laying down and taking up torpedoes. If we went to war the Navy must be called in for this duty, and there were many places we should have to defend abroad by means of torpedoes, particularly our coaling stations, so that it was necessary to familiarise the men and officers to the use of these weapons, so as to get rid of that sort of dread, of an undefined nature, which must occur to anyone, with the knowledge of an unseen danger. The First Lord of the Admiralty had thoroughly recognised the importance of this new warfare, as was apparent from the increased expenditure he was going to propose for torpedoes and experiments—namely, 80,000*l.* for torpedoes and 4,000*l.* for experiments. Nothing he had said would, he hoped, be construed into criticism in any way whatever; but he had thought it right to bring the matter into public notice, as it had so completely changed maritime war. We might manufacture guns and build enormously powerful ships, but ramming and torpedoes must be the warfare of the day.

'*Fraser's Magazine.*'

Fraser, February, 1878.

The part which torpedoes will play in future naval operations remains uncertain, little or no light having been thrown upon the subject so far during the present war. They may be classified as follows: the stationary torpedo or ground mine; the outrigger or spar-torpedo; the Harvey or towing torpedo; and the Whitehead, locomotive or fish

torpedo. The first named is mainly a defensive engine, and of its effectiveness to prevent vessels from entering hostile ports there is no question. It is easy to defend a roadstead or harbour by ground mines in such a manner that almost certain destruction must befall any ship making the attempt. Fraser.

Of the outrigger torpedo it may be said that its successful use in a boat attack must be dependent upon a state of negligence or carelessness on the attacked side. It may be accepted as a maxim of naval warfare at the present day, that under no circumstances should a ship or squadron lie at anchor during night near any part of the enemy's coast from whence a torpedo expedition might be despatched, unless it is in a position to guard itself effectually against such an attack. Experiment has shown that on a dark night a swift launch, well handled and exhibiting no light, is practically safe from artillery fire. But, on the other hand, an attack of this kind may be frustrated by a cordon of boats and hawsers, a boom of spars, nets, or other devices, as was exemplified when a Turkish squadron off the Danube so foiled a Russian expedition. Ships so defended, however, are not in readiness for getting under way at short notice. Various plans have been suggested for permanent outside defensive fittings, in the shape of wire-nets and other things; but there are great difficulties in the way of adapting such appliances to sea-going ships, which must always be in readiness to encounter gales of wind and heavy seas, or to meet an enemy in battle.

The practical value of the towing torpedo still has to be proved. Like many other ingenious inventions, it has passed successfully through a set of elaborate experiments, but without the practical test of real service. A ship at anchor may be defended from it by similar means to those above mentioned, but more easily; while to make a contact with a vessel under steam, and properly handled, is no easy matter. Great skill and nicety of judgment are necessary in order to pass at the proper distance, and also coolness in the management of the tow-line; and although all this may be successfully accomplished by practised hands in repeated experiments, it becomes a very different matter when it has to be done under a heavy fire from an enemy close at hand—which would necessarily be the case. Towing torpedoes are supplied to all our ironclads, but in such vessels they are likely to prove a source of more danger and embarrassment than of utility. Since they are not intended to be slipped until a favourable opportunity for a contact presents itself, they are liable to be exploded by the enemy's projectiles before such moment arrives, and in that case would blow in their own ship's side. When towing, they would also

Fraser. be a source of risk to the ship, from the liability of fouling the screw during rapid and sudden changes of course and speed necessary in ramming manœuvres. The prescribed remedy for this danger is simple in theory—to cut the tow-line; but during such a condition of things the enemy would be very close, and as the people managing the torpedo would be in full exposure to his top-riflemen, they would very likely be picked off, and so the torpedo would be uncontrolled. These are by no means far-fetched suppositions, but are such cases as must be expected to happen in the course of an engagement. The towing torpedo is far better adapted for small handy vessels, specially contrived for the purpose, with proper means of protecting the men operating it from small-arm fire.

The Whitehead torpedo is a cigar-shaped machine about 16 feet long. To prepare one of these torpedoes for service, the two parts have to be got up from their several storerooms, put together in the ejecting tube, charged with air, and adjusted to the proper range and depth of water; and great care must be exercised in so doing that the propelling and steering apparatus be not disarranged by any blow, or the torpedo will not pursue its right course. Considerable danger meanwhile is incurred, because, if the head should be struck by a fragment of shell, or a splinter of iron, it would probably explode, and cause most serious damage to the ship, and possibly great loss of life. Supposing, however, that the torpedo is safely launched and pursuing its course, let us consider what are its chances of hitting the desired object. If both ships are stationary, and the distance known, accurate practice can be made; but if one or both ships are moving rapidly, with a constantly varying distance, the chances of a successful hit will be small. Recent experiments have shown that it is not feasible to discharge a fish torpedo right ahead with any success, when at even a moderate speed; for, as might have been expected, it commenced to diverge immediately upon entering the water, and pursued a most erratic course across the bows of its own ship. The most favourable position for attack by a fish torpedo would be at a vessel coming up astern; but as a viligant look-out would be kept by such vessel for an attack of this nature, the torpedo could not fail to be perceived, and it would be easy to avoid it by a sheer of the helm.

Now that the torpedo panic has in a measure subsided, and people are bringing reason and common-sense more into judgment in these matters, it is seen that there is much room for doubt as to the practical utility of offensive torpedoes except for special service and in special vessels. It is a question for very serious consideration whether it is

advisable to expose our costly ironclads to the risk accompanying the use of these delicate machines, seeing how entirely we are without knowledge of their service to such ships, and also that so much valuable space has to be sacrificed for them. There are many who think that it would be preferable to depend more upon the guns and the ram. That torpedoes will enter largely into the operations of future naval wars is not to be doubted, but the wisdom of including them in the equipment of our great ships is questionable. This, however, is not meant to imply the exclusion of the necessary appliances for fitting and laying down ground-mines, and for rigging torpedoes for boat-work, which can be carried without risk and in little space. *Fraser.*

Much interest has been excited of late in Messrs. Thornycrofts' fast torpedo-boats. The speed which these little vessels have attained is extraordinary; but here again we find how impossible it is to combine all essentials within confined limits; and they have but small capacity for the stowage of fuel, or for accommodating a crew. They are therefore more particularly suited for operations in narrow waters, such as the fiords of Norway, the channels formed by the countless islands fringing the Baltic shores, and similar places, where either the great depth of water, or its extent, precludes the use of fixed mines.

AMERICAN AUTHORITIES.

Admiral Porter, U.S.N.

Admiral Porter, U.S.N.

Annual report to the Secretary of the United States Navy, 1871.

In constructing a torpedo vessel there enter so many elements that the merit of the contrivance does not consist simply in the hull or steam machinery; for a slow hull, even if impervious to shot, would fall a prey to the weakest kind of steam vessel, provided the latter had great speed and *proper appliances* for destroying a vessel under way.

A torpedo vessel must have great speed and certain powers of resistance in the hull, but should not be encumbered with such a weight of iron as would make her unwieldy.

She should start rapidly, turn quickly, and be able to go astern as fast as ahead. She should bristle all round with torpedoes, which could be run out twenty-five feet, fired and rapidly reloaded. She should be divided into numerous compartments, to prevent her from sinking if struck by shot or shell, and she should present but a small

Admiral Porter, U.S.N.

portion of her hull above the water as a target for the enemy. She should carry in her bow a heavy rifled gun for offence or defence, in case of accident to her machinery, or other emergency. She should be provided with the best arranged towing and self-acting torpedoes, to be used as occasion requires, and her electrical apparatus, and the means of working it and the torpedo-machinery should be of the most perfect description.

. . . .

Hereafter torpedo vessels will be considered as the light dragoons of a fleet, lying ready when the ships are engaged and covered with smoke, to rush in under its cover and deal destruction right and left, or to tow some disabled vessel of the enemy out of action as a prize, or to blow her up if she declines to surrender.

Ramming will no doubt be extensively resorted to, but it will be found, in the first naval fight that takes places, that the torpedo will decide the result.

A fleet once brought to battle could no more elude these swift torpedo-boats than the unwieldy bison the Indian of the plains; but when contending with ironclads, which have a speed of from 14 to 15 knots per hour, a slow torpedo vessel would be simply worse than useless; she would invite failure or defeat. Any vessel of greater speed could blow up the torpedo-boat with the Harvey torpedo, or one on that principle, which on a swift vessel is, I am satisfied, one of the most effective instruments of destruction ever invented. Any ship can carry it, and even merchant steamers could rely upon it as an almost certain means of defence against an enemy's cruisers.

Report for 1874. Torpedoes as an auxiliary to large ironclads.

While I attach great importance to the torpedo as a means of offence and defence, I am yet afraid that we will run into the error of supposing ships of war can be driven from the ocean by means of it alone. Some imaginative people think that ships and guns will avail nothing hereafter, but the torpedo will do all the work, while others, who have not paid much attention to the matter, consider the torpedo of little practical utility. Both these conclusions are erroneous.

The torpedo after all is but an adjunct, and there are certain times only when it would have advantage over great guns, as a Remington rifle or a Colt's revolver would, under certain circumstances, be preferable to cannon in a fort.

The torpedo, although an important addition to other means of warfare, will not do away with anything that has preceded it. Ships

will only be built stronger and faster and guns heavier, while improvement will continue to be made in the torpedo and ingenious devices introduced to avoid it. . . .

Admiral Porter, U.S.N.

Report for 1878–9. Torpedo for attack and defence of vessels, with an opinion of those in use, and a suggestion for a new plan.

The history of torpedoes shows a large proportion of failures, and the destruction or imminent risk of the boats employed. Any fast vessel fitted with a bow-spar and not having the strength to ram an ironclad, would be obliged to slow down on approaching such a vessel, both for her own safety and that of her spar; giving the vessel attacked greater opportunity to cripple the boat, or to obstruct and break the torpedo gear. It would seem that the only form of bow-torpedo of practical use, is a heavy machine bar, worked below the water-line, not dependent on exposed guns, and fitted in the ram-bow of a fast and powerful compartment vessel, capable of pushing through all obstructions, and would be simply auxiliary to the ram.

Vessels fitted with side spars are expected to manœuvre so accurately as to pass alongside or astern of the enemy without slacking speed, and at just such a distance as to place the torpedo against her side or under her counter, where it is exploded by electricity at the instant of touching. This is very good in theory, but the experience of many experiments by vessels of all sizes attacking undefended, stationary, and brainless targets, with deliberation and at slow speed, have proved how difficult it is to judge of the distance, and what little chance there would have been in actual warfare of placing the torpedo against the enemy's side and firing at the proper time. Any accident to the cumbrous boom guns or topping-lift would be fatal; and even with a machine side-bar, firing by contact, the difficulty of accurate steering or the fouling of any obstruction, would prevent a successful accomplishment. Although superior to the wooden bow-spar, and possibly of some use for defence, the side-spar torpedo would be a total failure against a properly defended vessel at anchor, and of little practical use in attacking under way.

The Lay, the Ericsson, and other automatic torpedoes which may be seen on the surface as well by the attacked as the attacking party, and are so easily avoided, intercepted, or obstructed, are of no practical use whatever.

Fine shooting has been made with the Whitehead from a stationary platform at a fixed target, but give both platform and target a speed of 12 knots in varying directions, and a far different result would appear. Fired with precision at close quarters, a

Admiral Porter, U.S.N.

Whitehead might strike its object, if unobstructed. No successful use seems to have been made of it in the last war, although a few were found drifting about, and the only *reported* instance of its use was in the 'Huascar'-'Shah' engagement, where its direction was observed by bubbles on the surface, and was avoided by a change of course. If great speed can be attained by a fish torpedo (as said to be the case in Ericsson's last), and if it can be accurately aimed and projected in the heat of action, allowing for the speed of the two vessels, and if no obstruction can be devised for the attacked vessel to use, it is a good thing.

The machine bow-bar, auxiliary to a ram, and the Whitehead automatic, at close quarters, seem to be the only ones of practical value for attacking vessels of war that will hereafter be expecting and prepared for such annoyance.

Secretary of the United States Navy.

Secretary, United States Navy.

Report for 1878–9. Efficacy of torpedoes.

The torpedo has become absolutely essential to the effectiveness of any modern system of naval warfare. This terrible instrument has been carried to such perfection that a small shell filled with a few handfuls of composition will utterly destroy the largest ship in the world.

The torpedo can be as easily exploded below the water as upon its surface, by either concussion or electricity; and by whichsoever of these modes it may be done, it is probably as effective for the defence of harbours and ships as it ever will be. What is desired is to make it more effective for attack, so as to destroy an enemy before he can approach too near. To a certain extent our torpedo-boat, the 'Alarm,' can, with an increase of speed, be relied on for this; and she is, within a radius of 15 feet from her hull, a most formidable vessel of war. It would require but few of such ships to destroy an entire fleet of ordinary steam or sailing vessels. But even the 'Alarm' leaves unaccomplished what is so much desired in naval warfare, that is, the means of sending out the torpedo to such a distance upon the water as to cut off an enemy entirely before he approaches too near. Our experiments have led to the belief that this may be done, with reasonable certainty and within a reasonable distance, by boats carrying torpedoes and steered by electricity, either from the shore or the deck of a ship. As these boats would have neither officers nor seamen on board, they might be captured and lost in the event of failure, but if successful the vessel with which they would come in contact, whether

Secretary, United States Navy.

large or small, would be inevitably and immediately destroyed. Other experiments are in progress by which it is expected that a rocket-torpedo may be forced upon the water for a considerable distance, to be determined by the strength and quantity of the powder used, and exploded upon coming in contact with an enemy, dropping the torpedo under the water and firing it below the line of the vessel's armour. This, if accomplished, would be equally destructive. Yet another plan has almost, if not entirely, reached the point of actual demonstration. This is by means of a steam-launch, possessing extraordinary speed, so arranged that the explosion of the torpedo may be made to take place while the launch is at full speed, so that two men, if they can escape the balls of an enemy, may pass entirely through a fleet and destroy every ship they succeed in reaching.

Captain Ericsson has constructed a partially submerged and armoured vessel, intended for greater speed than any ironclad, and capable of projecting a submarine shell with great velocity and accuracy to a distance of 300 or 400 yards, which is probably as far as any offensive torpedo is likely to be effective at sea. Some preliminary trials have been made by the inventor, and a board has been ordered by the departments at his request, for an official trial when it is ready for service. The same torpedo can be effectively employed from any vessel fitted with a tube above or below the water and the machinery for ejecting the torpedo.

If the practicability of all or any of these experiments shall be established, our monitors and torpedo-boats would furnish the amplest protection to all our harbours against any possible enemy, no matter what the size or character of the attacking ships.

Lieutenant Bradford, U.S.N.

Lieutenant Bradford, U.S.N.

Report on experiments in Bay of Florida, 1875.

In his report to Rear-Admiral Ludlow Case, of the United States Navy, on the torpedo experiments which were carried out in the Bay of Florida, in February 1875, Lieutenant Bradford remarks that it must have required a powerful imagination ever to have supposed that a wooden ship of an antiquated type, and with a speed of 6 knots, could if she liked destroy a powerful ironclad, steaming 12 knots, simply by means of a powder barrel at the end of a pole. He adds, however, that it would in his opinion be an error to say that it is useless for these same old wooden ships even to make an attempt to use torpedoes or to have them on board; for if they even should succeed in getting alongside a ship of superior strength and speed,

Lieutenant Bradford, U.S.N.

either by surprising her at night when at anchor, or in any other manner, the torpedo would furnish them with a means of destroying her which they would not otherwise possess. It is moreover a fact that torpedoes may be applied to many other purposes, such as protecting ships at anchor, blowing up other torpedoes, or removing obstructions in a channel, in disembarkation and night attacks.

Admiral Porter.

Admiral Porter, U.S.N.

North American Review. Torpedo warfare.

Though the invention of the submarine torpedo dates back to 1775, there is no implement of warfare that has made so little progress, considering its destructive power, or about which there are so many conflicting opinions. It is only since the year 1861 that it has been generally adopted as an engine of war, a tardiness in great measure due to the false sentimentality which, until a recent period, banned the torpedo as an inhuman and unchristian means of destroying an enemy. This sentimentality, it may be remarked, has never prevented Christians from mowing down an enemy with grape-shot and canister, or setting fire to his ships in order to roast as many of their crews as possible; hence it is difficult to see the consistency of such humane scruples.

Among the arguments urged against the introduction of the torpedo was that its use would not foster the bravery and chivalry which have characterised the naval profession, more especially that of Great Britain; and Great Britain, having the most powerful Navy of the world, and claiming the title of Mistress of the Seas, did not deem it prudent to encourage a mode of warfare which would tend to place her on an equality with weaker nations. Were it not for this obvious reason, she would no doubt have given particular attention to so effectual a means of destroying an enemy, and would long ago have brought the torpedo to perfection, since, at the date of its invention, she was the leading nation in the mechanical arts, and her inventors would soon have overcome the difficulties which stood in the way of practically using this arm. Now that she sees every nation adopting the torpedo, and her splendid fleet of ironclads imperilled, she is with characteristic energy making every effort towards the improvement of this most terrible engine of war, and will doubtless bring it to a greater state of perfection, both for offence and defence, than it has yet attained. As the torpedo has now become a vital necessity to Great Britain, she will lose no time in adapting it to all operations of naval warfare; and as it is generally

adopted among the navies of the world, she will provide effectual means of resisting it when sent against her fleets. *Admiral Porter, U.S.N.*

Whatever prejudices—sentimental or otherwise—may once have existed against the torpedo, they have all vanished before the necessities of the time. Self-defence is the first consideration with nations as with individuals; and it is now conceded that Governments subserve not only their own interests, but those of mankind, by using a weapon that will soonest decide the result of war, and which will most effectually protect their coasts.

On looking back to the War of 1812, when eighteen and twenty-four pounders were the largest guns we possessed, we wonder that nations could ever have relied on such feeble engines, or expected great results from their use. In recent years monster rifled guns have been invented, throwing upwards of two thousand pounds' weight of metal, and mounted on huge floating batteries almost impervious to shot and shell. One such vessel might have destroyed all the fleets Nelson ever commanded, and have bid defiance to the works of a Vauban; it would heed the forty-two pounders of the past about as much as an iceberg would a volley of peas.

There is no human invention that is not susceptible of improvement. This seems to be a law of Nature, by which man's inventive faculties are kept ever on the alert, and nations are advanced in the arts of war as well as of peace.

It may seem a strange thesis to maintain, that the torpedo is a beneficent invention, yet all peace-loving men should approve of it, inasmuch as it tends to preserve peace and to prevent powerful nations from trampling on their weaker neighbours. Nations are not half so apt to go to war to-day as they were a few years ago when the torpedo was considered a doubtful auxiliary, quite as likely to prove disastrous to the operator as to the enemy. We have seen the caution with which England and Russia watched each other during the crisis of the Eastern question, and the wily game both played. Time was when Britannia would have struck a blow first and treated afterwards; but, since her last great naval wars, which gave her victory at almost every step, new elements have been imported into warfare afloat—elements which, as a rule, meet with no particular favour among naval officers generally.

Space would fail me to describe here the various forms of the torpedo, as it has been successfully modified and improved; and all that I can attempt to do within the limits of this article is to note the principal stages of its development. . . .

In 1861 a new era in naval warfare was inaugurated. The in-

Admiral Porter, U.S.N. genuity of Ericsson brought forth the famous 'Monitor', and the energy of the Southern naval officers who had joined the Confederacy rendered the 'Merrimac' almost invincible. These were then the most powerful vessels in the world; and the people of this country will never forget the peculiar sensation they experienced when it was announced that the huge 'Merrimac' had broken loose, was destroying everything in her track, and threatening to proceed to Washington and hoist the rebel flag on the Capitol. This sudden onset of so terrible an adversary at once induced our Government to devote attention to the subject of torpedoes, which they had so long neglected; and in this they were stimulated by the action of the Confederate naval authorities, who, owing to our superiority in ships, had devoted all their energy and ingenuity to this method of warfare. Being well informed of the number of ironclads we were building, and seeing the hopelessness of contending against such odds, even by the purchase of ships abroad, the Confederates were forced to adopt new modes of defence. They were aware that our iron ships were practically impenetrable to the most improved artillery, and determined to meet us with a new element of war, which they felt would outweigh the power of any vessels we could bring against it. No matter how strong an ironclad may be, or how difficult to penetrate with shot or shell, the bottom of the ship is always a point of weakness, and is actually more vulnerable than that of a wooden vessel, having less elasticity and less resisting power under water. To this part of our vessels, then, the Confederates determined to pay particular attention, with what success will appear in the history of the torpedo warfare which they inaugurated. With such a great extent of sea-coast open to the attack of our cruisers, and with the numerous navigable rivers which traverse the South, the Confederates had extensive facilities for using the torpedo, and a reasonable prospect of success in driving us from their inland waters.

Without entering into details, I will state that, a short time after the design was formed of using the torpedo extensively, a torpedo corps was established by the Confederates, which had exclusive control of this arm of defence. Competent officers who had served in the United States Navy were mostly in command of the parties; and, as far as I can learn, the system was first employed in the channels of approach to Wilmington and Charleston, and later in the harbour of Mobile. Besides their forts, these places were defended by sunken torpedoes, which were protected from any interference by the batteries near at hand. There is no end to the shapes and characters of these

Confederate infernal machines, which are graphically described in the excellent work on 'Torpedoes' by Lieutenant-Commander J. S. Barnes, U.S.N. *Admiral Porter, U.S.N.*

Most of the Southern seaports fell into our possession with comparative facility; and the difficulty of capturing Charleston, Savannah, Wilmington, and Mobile, was in a measure owing to the fact that the approaches to these places were filled with various kinds of torpedoes, laid in groups, something on the plan of Fulton and Colt, and fired by electricity. The introduction of this means of defence on the side of the Confederates was for a time a severe check to our naval forces, for the commanders of squadrons felt it their duty to be very careful when dealing with an element of warfare of which they knew so little, and the character and disposition of which it was so difficult to discover. In this system of defence, therefore, the enemy found their greatest security; and, notwithstanding all the efforts of Du Pont and Dahlgren, Charleston, Wilmington, and Savannah remained sealed against our naval forces until near the close of the war. Many acts of heroism were performed, and the lives of gallant officers and men sacrificed, to remove these formidable obstructions; but as fast as the infernal machines were taken away by our forces, fresh ones were put in their places, backed by piles and other obstructions, and directly under cover of the enemy's heavy guns. There was never an occasion when the utility of torpedoes was so fully illustrated as during our blockade of the Southern ports. They kept our ships out, and allowed the blockade-runners to pass in with impunity, supplying the enemy with the sinews of war until near the end of the contest, when the last of these strongholds, Fort Fisher, was captured. The Confederates did not use torpedoes at the forts below New Orleans when they were captured by the naval forces, otherwise it might have been a more difficult operation. The wonder is that they were not used, as the place offered many facilities for planting and firing them as our fleet passed up, or floating them down on the ships anchored in the stream below the forts, where for many days they offered fair objects for this kind of enterprise. I am confident that with our present knowledge of the subject no fleet could pass those forts.

When I took command of the Mississippi squadron in 1862, I was almost immediately called upon to assist the army in the attack on Vicksburg, and heard for the first time that the Yazoo River, where the army under General Sherman intended to disembark, was filled with torpedoes. I at once sent a force in that direction, under Captain Walke, to clear the river of obstructions. The duty was a dangerous one, and officers and men were much exposed while

Admiral Porter, U.S.N.

dragging the river, cutting the wires, and bringing the torpedoes ashore. The machines would sometimes explode, but, thanks to careful handling, no material damage was done. Officers and men had already learned to respect those little lumps of iron, which, without warning, could send a whole ship's crew to destruction. All the time our people were at work at this dangerous duty, they were fired upon by sharpshooters from rifle-pits along the river banks; but these were finally driven away by grape and canister from the gunboats, which were as obnoxious to the Confederates as their torpedoes were to us. The river had been dragged for a distance of eighteen miles, and there was a fair prospect of removing all the torpedoes without loss, when one exploded under the bow of the ironclad 'Cairo,' Lieutenant-Commander Selfridge, and in less than three minutes that fine vessel went to the bottom. Fortunately, there was no loss of life, the officers and crew being picked up by surrounding boats. This was a great success for the enemy, for with a fifty-dollar torpedo, they had succeeded in destroying an ironclad costing three or four hundred thousand. However, the Yazoo River was for a time completely freed of torpedoes, and General Sherman landed his army at the best point on the river without being molested by the Confederates.

The next accident I had from torpedoes occurred on the same river later in the war. Lieutenant-Commander J. G. Walker had been sent in the ironclad 'Baron de Kalb,' a sister vessel to the 'Cairo,' to destroy the enemy's Navy Yard at Yazoo City. When our force arrived off the town, the enemy's troops opened fire with artillery on the ironclad and her consorts, and Walker, steaming rapidly ahead, returned the fire. In a moment the bow of his vessel was blown into the air by the explosion of a submerged torpedo, and all hands were swimming in the river, but were rescued by the boats of the accompanying vessels, while their own vessel went to the bottom a total loss. This catastrophe did not prevent those gallant fellows from pushing ahead and capturing the town, destroying the Navy Yard and two powerful ironclad rams on the stocks, and filling their remaining vessels with ordnance and other valuable stores captured from the enemy. Thus it will be seen that the torpedoes in no wise demoralised our men. When the 'Baron de Kalb' was afterwards examined, it was found that the three nine-inch bow guns were thrown upon their backs, and the vessel and engine completely knocked to pieces. Yet the torpedo that did the mischief was simply a three-gallon demijohn filled with powder and ignited by a friction-fuse, a more primitive machine than Fulton had ever experimented with.

From this time forward we heard more of torpedoes, but, as stringent regulations were issued regarding them, no mishap of consequence occurred; but vessels ascending small rivers always carried in advance a long pole bearing a deep net, with which to scoop up any torpedoes that might be in the way. *Admiral Porter, U.S.N.*

About May 1864, a new description of Confederate torpedo was brought to my notice. By assiduous watching of small boats crossing the Mississippi, I succeeded in capturing a package of despatches which fully explained the organisation of a corps of Confederate torpedo-setters, together with the names of the parties concerned, and their commissions signed by Mr. Mallory, 'Secretary of the Navy.' This old sea-dog, not having any vessels wherewith to operate on the ocean, except the one commanded by Semmes, his *beau idéal* of an incendiary, organised a body of horse-marines to patrol the shore, who were directed to sink, burn, and destroy every Union vessel on the Mississippi and its tributaries by means of the new style of infernal machines. In order to circumvent these machinations, I appointed a corps of detectives to travel in all merchant steamers, and win the confidence of the rebel operators. Some of the latter ended their career very suddenly. The general order which I thought necessary to issue at that time recites the reckless character of the people with whom we had to deal, who, notwithstanding their diabolical warfare, would under other circumstances have been sufficiently tender-hearted if called upon to use only eighteen-pounders. One very valuable vessel was destroyed by these infernal machines. She was used as a 'wharf-boat,' or store-ship, at the Mound City Navy Yard, was six hundred feet long and sixty wide, and filled with stores for the fleet. Notwithstanding the greatest vigilance was exercised, a torpedo resembling a lump of coal was introduced on board, and the vessel was destroyed by the fire which took place after the explosion. At the time of this occurrence, my flag-ship, the 'Black Hawk,' was made fast to the wharf-boat, and the first notice I had of her danger was a slight explosion, when the whole vessel was immediately wrapped in flames. Here was a torpedo beneath the notice of the Bushnells and Fultons, yet sufficiently effective in its particular line.

It would perhaps require a subtle casuist to determine how far such contrivances are justifiable in war. My own reason and experience have taught me that the most prompt and harassing measures are the best; and if ever war is made so dangerous that every combatant will to a certainty be killed, then there is an end of the business, and the Peace Society can put up their shutters. I had rather

Admiral Porter, U.S.N.

an exciting time with some of the explosive land-torpedoes operated by Secretary Mallory's horse-marines. In the fall of 1864 I was at Dutch Gap on James River, making arrangements for the government of the naval forces left to take care of the obstructions in that stream, and to prevent the rebel fleet coming down while I was absent at Fort Fisher. General Butler came up soon afterwards in a swift steamer called the 'Greyhound,' and, as he desired to see me on some public business, I started to accompany him in that vessel to Fortress Monroe. Dutch Gap was then the rendezvous for all kinds of people who were working on the famous canal; many of them their own mothers would not have recognised, and, a thing that could hardly have been prevented, emissaries from the enemy's camp frequently visited the place. As we steamed down the river I drew General Butler's attention to several rough-looking fellows on deck, and he ordered the vessel rounded-to at Bermuda Hundred, and turned the strangers over to a guard. We then continued on our way, but in about half an hour an explosion took place in or near the furnaces, and the vessel was almost immediately in flames amidships. The crew jumped overboard, and we in the after-part lowered a boat and just managed to escape from the flames. It was my belief that the men we had set on shore had deposited some of their infernal machines among the coal; at the proper time they exploded, and the result was the loss of a beautiful steamer, with a fine lot of horses belonging to the General. The work of these incendiaries was so thoroughly done that in ten minutes from the time of the fire breaking out not a vestige of the steamer remained.

During the Red River Expedition, in the spring of 1864, the Confederates used every effort to give us a warm reception, and torpedoes were planted all along the river, which we removed as we passed up. On our return down the river, the 'Eastport,' a splendid and costly ironclad ram, struck a torpedo, which apparently contained not more than twenty pounds of powder, and in five minutes the vessel sank in shoal water. I brought to the assistance of her commanding officer two heavy pump-boats, and by pumping and bailing managed to get her 200 miles farther down the river, where her progress was effectually stopped by a tremendous barrier of logs. Any attempt to force the ironclad through this would have exposed the rest of the vessels to destruction, many of them being already badly cut up, so I ordered the 'Eastport' to be blown up. This was the last vessel of my command that was sunk by torpedoes on the Western waters; but had Mallory's horse-marines shown common energy and intelligence in resisting, with their torpedoes, our advance up Red River, few if any of our vessels would have escaped.

Admiral Porter, U.S.N.

I mention these occurrences to show how very destructive a small quantity of powder or guncotton can be made to an enemy afloat; and, although Fulton was so violently opposed and ridiculed, he was not much out of the way in advocating a torpedo corps, to consist of 1,000 boats, with their complement of officers and men, to attack the enemy's vessels, wherever they could be found at anchor or in a calm. In Fulton's day such a notion received less encouragement than would now a scheme for transporting passengers to the Paris Exposition by a balloon. Of late years, so great has been the progress made in the sciences and mechanic arts that there is no longer room to question the success of this once dubious system of naval warfare.

All told, we lost nearly twenty vessels from torpedoes during the war of the rebellion. Most of the occurrences were simply mentioned in the public despatches of the time, and are, hence, not familiar to the general reader. Persons unacquainted with a sea-life are apt to imagine it a fine thing to be a naval officer, roaming about the world in a noble ship, with all sail set alow and aloft, and doubtless it is a privilege to serve one's country in so honourable a calling; but this is only the rose-coloured view of the matter, and there are very many incidents in the profession which would be exceedingly distasteful to a landsman—among them the liability to being blown to atoms when skimming over the bosom of a summer sea. Who does not remember the fate of the gallant Craven and his officers and men, when fearlessly advancing in the 'Tecumseh' to the attack on Mobile, how the ship encountered a hundred-pound torpedo, and in 30 seconds after the explosion went to the bottom, leaving but a few survivors to tell the story? Here was a vessel, costing over a million dollars, destroyed by a small torpedo which cost less than one hundred.

The case of the 'Commodore Jones,' a large gunboat that was blown up at Deep Bottom, on James River, was a particularly painful one. This vessel was at the time employed in dragging for torpedoes, and was surrounded by row-boats employed in the same service. The captain having been notified by a negro pilot that he was near sunken torpedoes, the gunboat's engines were stopped and she commenced backing. Scarcely had she gathered stern-way, 'when suddenly and without any apparent cause she appeared to be lifted bodily, her wheels rapidly revolving in the air, and persons declared they could see the green grass of the river bank beneath her keel. An immense fountain of foaming water shot to a great height, followed by a denser column thick with mud. The vessel absolutely crumbled to pieces, dissolved as it were in mid-air,

Admiral Porter, U.S.N.

enveloped by the falling spray, mud, water, and smoke. When the excitement of the explosion subsided, not a vestige of the vessel remained in sight, except small fragments of her frame which came shooting to the surface.' Nearly every one on board was killed or wounded. This vessel was destroyed by a charge of about two thousand pounds of powder contained in a tank and fired by electric wires. It is needless to say that this catastrophe checked the advance of the other vessels astern of the 'Jones,' but measures were immediately taken to capture the torpedo-operators, who, to save their lives, pointed out the location of other infernal machines, and explained the secrets of their torpedo service.

The Confederates took particular pains to defend the James River by torpedoes, which had the effect of completely closing it against the approach of the United States vessels. Our fleet would have been destroyed in detail had it attempted to force its way up against the concealed torpedoes protected by heavy batteries. In the early part of 1864 the Confederates had completed their system of defence throughout the South, and the difficulty of approaching their strongholds through their lines of torpedoes was almost insurmountable. The ideas of Fulton seemed to have taken possession of our humane friends at the South, and it would require a book to describe all the incidents connected with Confederate torpedo warfare, and to recite the damage we sustained in the latter part of the war, when the enemy had by means of blockade-runners imported hundreds of electric batteries, and tons of iron carcases to be filled and distributed, as occasion required, through all parts of the Confederacy. Every navigable stream within their jurisdiction was amply defended by submarine batteries; and General Beauregard remarked concerning Charleston, that he attached more importance to one of his pet torpedoes for the defence of that place than to five ten-inch guns; and well he might, since our ironclads were impervious to the latter, and entirely vulnerable to the torpedoes.

The following is a list of our vessels destroyed or severely damaged after the Confederates had succeeded in getting their torpedo system in full operation. Some of the saddest episodes of the war were in connection with the loss of these vessels—'Cairo,' 'Baron de Kalb,' 'Eastport,' a wharf-boat, 'Commodore Jones,' 'Tecumseh,' 'Ostego,' 'Basely,' 'Patapsco,' 'Harvest Moon,' 'Milwaukee,' 'Osage,' 'Rodolphe,' 'Scioto,' 'Ido,' 'Althea,' 'Housatonic' —to say nothing of injuries to vessels, destruction of boats, and a somewhat demoralising effect temporarily produced on a Navy which has never yet declined to attempt the most hazardous undertakings.

If, after investigating the results of torpedo warfare since the year 1862, any one will undertake to decide against its efficiency, I should give him little credit for judgment. Had we established at the beginning of the war a torpedo corps superior to that of the Confederates, supplied with the modern appliances, we might successfully have fought torpedo with torpedo, and, if the Confederates blocked up the inside of their rivers, we could have blocked up the outside channels with such contrivances that the blockade-runners would either have been blown up or kept out of the harbours, and the enemy would soon have been deprived of the sinews of war. In whatever shape torpedoes are employed, there are always two sides to the game, and it must not be supposed that it will belong exclusively to one party. We showed during the war either a want of intelligence in not using torpedoes, or an excess of humanity, and a rash confidence of easily overcoming a vigilant and energetic foe, a confidence which was not justified by our experience as the war went on. But since the close of the war we have paid particular attention to the subject, and at present are as well informed in all that relates to the torpedo, and as ready to discard our false notions of humanity, as any other nation, for at present the naval Powers of the world are acting as if they almost believed in Fulton's prophecy, that the torpedo would 'finally revolutionise all naval warfare.' *Admiral Porter, U.S.N.*

Hitherto I have alluded principally to the torpedo as used for the defence of rivers and harbours, but that is not the most formidable mode of employing it. Since the close of our war the torpedo-vessel has been successfully developed; and now that the nations of Europe have constructed great ironclad fleets armed with monster guns, the admiration of the world, behold there springs into existence this little ocean scorpion, bristling with outriggers and exploding tails, and endowed with a speed sufficient to overtake or escape from the strongest ships! A naval officer might almost stand aghast at the prospect of his ship being struck unawares by one of these stealthy and effective sea-devils. He will dread them in the future as the whale dreads the sword-fish: when once the enemy has struck, there is no hope of escape; and the blockheads who have pooh-poohed the torpedo-vessel as a harmless affair, will be the first to surround their ships with logs and nets, so as not to be blown into eternity while quietly eating their dinners.

The Confederates were the first to use the torpedo-boat and began by launching several cigar-shaped vessels, each about 50 feet long, propelled by steam, and carrying a torpedo on the end of a boom, which could be run out, lowered under a ship's bottom, and

Admiral Porter, U.S.N. fired. These vessels were called 'Davids,' in allusion, I suppose, to the story of David and Goliath. The 'Davids' were rather crude affairs, and drowned their own people oftener than those they were in pursuit of, but they kept our blockading forces very uneasy, harassing them continually. On the night of October 5, 1863, a 'David' got alongside the ironclad 'New Ironsides,' off Charleston, and, exploding a torpedo against her side, shook the ship terribly, and did considerable damage. On the night of February 17, 1864, a 'David' attacked the sloop-of-war 'Housatonic' lying at anchor outside Charleston Harbour, and blew a hole in the ship's bottom, which caused her to sink in a few moments. After the war it was discovered, on examination of the wreck of the 'Housatonic' by divers, that the torpedo-boat which destroyed her had run partly into the opening made by the explosion, so that all on board the 'David' found a watery grave.

Many of our vessels were at different times during the war attacked by torpedoes fitted to steam launches, which did great damage, rendering the vessels useless, at least for the time being; among the vessels lost in this way were the 'Minnesota' and the 'Wabash,' two of our largest frigates. These torpedo-boats were small affairs, mostly improvised for the occasion, with incomplete apparatus and insufficient charges; but they were a step in the right direction, and are the originals of the perfected torpedo-vessel which will in the future decide the issues of naval battles.

The nations of Europe are now actively engaged in perfecting the torpedo-vessel, and the results are very encouraging. Torpedo-boats of great speed and capacity for mischief have been designed; while England, with characteristic stubbornness, has so far done little in this direction, trusting more to her iron bulwarks and stout tars than to a mode of warfare which the conservative blue-jacket will still insist upon styling contemptible and cowardly, fit only for Chinamen and Feejee Islanders. At this moment no nation can afford to ignore the torpedo, either as an offensive or defensive weapon; to do so would be evidence that they had not observed the recent great improvements, or that observation had taught them nothing. When I hear a naval officer speak contemptuously of the torpedo, saying that it can be of no great use in time of war, I set him down as one whose opinion is of no consequence on that or any other professional subject, for he has either benefited nothing by experience, or has never had any experience by which to benefit. It is true that the torpedo will not so change the character of naval war that great ships will be dispensed with; for, in proportion as this engine is developed,

new contrivances for withstanding it will be invented. The nation that possesses the most powerful fleets will, as heretofore, dominate its adversaries on the sea, and we shall live to see perfected torpedo-vessels engaging other torpedo-vessels on the ocean, as we see the light-cavalry combats of two contending armies. *Admiral Porter, U.S.N.*

The idea has got abroad among superficial observers that large ships of the present type will disappear before the advent of the new torpedo-boat, and that torpedoes planted in channels will render forts and heavy guns unnecessary—an opinion which is not shared by experienced persons. Under the guns of a heavy fleet torpedoes can be raised from a channel at night, by men in submarine armour, or the machines can be made useless by cutting the firing wires, or ships can use certain appliances which, in many cases, will neutralise the effects of torpedo-boats. A watchful commander will be always on the alert for these little sea-devils, his nets ready for service, and his own torpedo-launches on the *qui vive*. At night his electric lights should illuminate the surrounding waters, and his guns be ready to pour in grape on an approaching foe. It is true that torpedoes in channels at times stopped the advance of our naval forces during the late civil war, but we had not always a sufficient strength in ships and guns to overcome the forts which were always ready to drive away our boats when groping for the hidden enemy. The torpedo is a powerful adjunct in war, but nothing more. It cannot bombard an enemy's forts, or lay his cities under contribution, nor can it cruise for, cut up, and destroy, a merchant marine. It cannot transport troops to invade a foreign country; it is simply a most destructive and harassing machine, making war much more horrible while it lasts, but incapable of successfully operating unless backed by powerful ships, which will, as heretofore, doubtless prove the chief naval strength of the various nations.

Every ship, large or small, can, in a measure, be converted into a torpedo-vessel, projecting the Whitehead torpedo from her sides, or operating the Lay torpedo from her deck; and the greater speed which, other things being equal, a large vessel must have, as compared with a small one, would perhaps render the former more efficient in this mode of warfare than the latter. Torpedoes, in combination with rams, will so far change the character of naval warfare, that there will be no more sea-battles fought in extended lines, as of old, but fleets will fight in groups of three or four ships, with a combination including the gun-vessel, ram, and torpedo, so that each can support the other, and an intelligent commander can manœuvre without danger of collision or breaking the line of battle.

Admiral Porter, U.S.N.

Some of the swiftest torpedo-boats yet constructed are on the plan of Thornycroft, of England, but they hardly seem to deserve the high estimate which some writers have put upon them, for in a heavy seaway they are useless. The torpedo-vessel, to be thoroughly effective, should be able to keep the sea in any weather, steam at the rate of seventeen knots, be wholly impervious to grape, and partly so to shot, and be fitted with all the improved torpedo devices.

The United States have as yet done very little practically in the way of using torpedoes. Our naval vessels are fitted with a torpedo-spar which is now out of date, and should give way to new contrivances. We have built one good torpedo-vessel, but she is deficient in speed, without which no vessel of this kind can be depended upon at sea; but she will answer very well for harbour defence, until improved machinery is provided to drive her fourteen or fifteen knots. In other respects she is a formidable vessel. We have at Newport, Rhode Island, an excellent school for instruction in torpedo warfare, and some twenty young officers graduate there each year, carrying with them information which in case of war will be of the greatest value. We possess numerous torpedo inventions which have been practically tested at Newport before boards of officers. Some of these contrivances are very good, and others sufficiently primitive; but I hesitate to particularise any of them, since, if I spoke doubtfully of some, their inventors would consider it a special grievance.

During the late war we never made but one serious attack on the Confederates with the torpedo, but that affair was too remarkable to pass unnoticed here. The Government had sent to Hampton Roads three steam-launches fitted with torpedoes on the end of a pole, devised by Chief-Engineer Wood and Assistant-Engineer Lay. The torpedo consisted of a copper case with a hollow tube through the centre, at the bottom of which was fixed a cone for a fulminate cap; at the end was an iron ball to act as a plunger and explode the cap, the ball being held by a safety-pin. An inclined partition divided the interior of the torpedo into a magazine and an air-chamber. The disposition of the charge caused the torpedo to take position in the water with the chamber uppermost, with the trigger-line attached to the pin to lead so as to give a direct pull from the boat. The poles lay alongside the boat, and when run out took an angular course under a ship's bottom. Lieutenant Cushing having given personal attention to the fitting of these steam-launches, and having originally proposed the blowing up of the 'Albemarle,' by direction of the Department I sent him to execute this dangerous

duty. He was fully equipped, and had instructions to proceed to the sounds of North Carolina, communicate with the commanding officer of the flotilla, Commander Macomb, and make all his dispositions to destroy the rebel ram (the Confederate ironclad ram 'Albemarle'), then lying off Plymouth, North Carolina, which vessel was bidding defiance to our flotilla of six or seven vessels, had disabled some of them, and kept all hands in a decidedly uncomfortable frame of mind. Everything worked well, and Cushing was not discovered by the enemy until he had come close alongside the 'Albemarle,' on the night of October 27, 1864. The vessel was surrounded by logs and other obstructions. In pushing his pole over the logs, and forcing his boat partly through them, he exploded the torpedo, and the 'Albemarle' was so much injured that she sank while firing upon Cushing with great guns and small-arms. The torpedo-boat filled with water, and Cushing and some of his brave companions escaped by swimming; others were drowned, and the rest taken prisoners. As soon as Macomb received notice of Cushing's success, he pushed up a back inlet as I had directed, and, taking the enemy in the rear, captured the town of Plymouth and the defences, with some nine or ten heavy guns, together with a large supply of small-arms, stores, &c.—all resulting from the performance of a little torpedo-boat with fifty pounds of powder on the end of a pole! This success gave us entire control of the sounds of North Carolina, which control we ever afterwards maintained.

Admiral Porter, U.S.N.

History has done justice to this affair, and Cushing received the most enthusiastic commendation for his gallant conduct; but success was also owing to Commander Macomb, who had all the arrangements carried out, and performed so gallantly the final *coup* by which the 'Albemarle' fell into our hands, with the other spoils of war. She was afterwards raised, and found to be unhurt, with the exception of a small hole in her bottom.

Of all torpedo experiments this was the most interesting that ever came under my observation. Here was a great ironclad, costing perhaps a million dollars, a vessel that had successfully resisted and inflicted great damage on a fleet carrying some very heavy guns, and was only making a few additions to her strength preparatory to capturing or destroying Macomb and all his forces. The town of Plymouth, a valuable strategic point, with all its guns, stores, &c., fell into our possession, through the gallant action of a handful of officers and men, and the intelligent use of a small torpedo-boat. Macomb and Cushing have gone to their long home, but the memory of their bravery and good judgment I shall ever cherish.

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The sinking of the 'Albemarle' so convinced me of the value of the torpedo-vessel, that I have ever since been deeply interested in the subject, and have constantly endeavoured to improve upon the designs which have been presented to the public. I am acquainted with the details of nearly fourty automatic powder-torpedoes, and a number of others charged with guncotton and dynamite, and fired by electricity. Every one of the above, with very simple mechanism, would perform its work effectively, but it would be impossible to give a name to these things, much less write a satisfactory description of them. The most widely-known torpedo at present, and the one most approved by authorities in Europe, is the Whitehead, or fish torpedo, the invention of an Englishman named Whitehead. The details of its construction are not publicly known, being imparted only to certain persons in the navies of Great Britain and Austria, each of which Powers has paid the inventor twenty thousand pounds sterling for his secret.

The Whitehead torpedo is cigar-shaped, propelled by an engine using compressed air, and is discharged from a vessel or from the shore, running at the rate of sixteen miles an hour. It can be set to run on the surface or at any required depth, and explodes on striking an object. Although the Whitehead has given better results than any other torpedo of its class, it has several eccentricities of character, sometimes turning about without notice and making for its friends, or exploding prematurely. The distance this torpedo can run is in proportion to the size of the motor which gives it its speed and direction. To show the unreliability of the Whitehead torpedo, I will refer to the engagement between the Peruvian ironclad 'Huascar' and two British men-of-war. The 'Shah,' one of the latter, sent a fish torpedo against the 'Huascar,' which, seeing bubbles of air rising to the surface, avoided the machine, and it ran straight into a harbour near by; there, the compressed air being gradually expended, the torpedo rested quietly alongside a Dutch merchant vessel at anchor, with no power to do harm. The Dutch captain, seeing what he supposed to be a live fish alongside, got out his fishing-tackle, but was disgusted at not getting a bite; only after several unsuccessful attempts with a harpoon did he discover the nature of his visitor. The Whitehead may, under certain circumstances, be a destructive instrument, but, owing to its erratic movements, it is liable in the heat of battle to prove dangerous to its friends.

The torpedo-vessel will, in the end, I am convinced, prove a most effective and certain means of offence, as its movements are at all times under the entire control of its commander, who can select his own time for attack and retreat.

No detailed account of torpedoes could be given within the limits of an ordinary article, and I have only attempted to deal with general principles, referring for a more complete illustration of this subject to the various works in which it has been treated. *Admiral Porter, U.S.N.*

CONTINENTAL AUTHORITIES.

FRANCE.

Minister of Marine.

Minister of Marine. — Speech in the Chamber of Deputies, 1878.

Torpedoes must not be left out of our consideration; they are a powerful engine of war. This has been shown by recent experience. The war in America, like that which is now being carried on in the East, has shown that it may be employed with effect both for offensive warfare against ships and for the defence of roadsteads. We must, however, take care not to exaggerate its importance.

It is a powerful weapon, but it is one which we can scarcely regard as capable of being used as an ordinary resource. Its efficiency for offensive warfare will depend on opportunity and firm resolution.

I am only led to speak in these terms, lest our confidence in the use of the other weapons which we possess, such as our large ironclads, powerfully armed, may be unduly disturbed.

GERMAN NAVY.

Revue Maritime, November, 1874.

The programme for the construction of the German Navy includes eight first-class ironclads, eight armoured corvettes, fifteen monitors and floating batteries, twenty wooden corvettes, eighteen gunboats, and eighteen torpedo-boats. The greatest attention is given to torpedoes in conformity with the well-known expressions used in Parliament by General Stosch, the head of the Admiralty. 'Give me,' he said, 'a small ship, a good torpedo, and a brave commander, and he will have a good chance of blowing up one of the heavy modern ironclads.'

The above information, as taken from the *Revue Maritime* of November, 1874, represents the proposals which were at that date adopted in Berlin. The growing confidence in the efficiency of the torpedo has led to subsequent modification; the result being that

Revue Maritime.

four large monitors which had been voted by the Reichstag for coast defence have been abandoned, and the number of torpedo-boats has been raised from eighteen to thirty.

SWEDEN.

Discussion at the Naval Institute at Stockholm, October, 1877. Translated from the Swedish *Maritime Review*, published at Karlskrona.

Torpedo-boats must have a speed of about ten knots. The crew and the torpedoes must have some protection. The boats must be of light construction and easily manœuvred. Some officers thought that the manœuvring qualities were more important than a speed of ten knots, and on this point there was an animated discussion.

The torpedo-boat, which was considered not more than ten years ago as almost a weapon of precision for purposes of attack, would no longer be able to force its way through the defences which have been provided. The chances of taking an enemy by surprise may be said to have become more and more remote, now that, on the darkest night, by means of the electric light, the approaching boats can be detected, and an overwhelming fire can be at once opened upon them from guns and rifles.

There are, however, few obstacles which cannot be overcome by the combined efforts of the genius and power of man, when he is prepared to sacrifice his life to gain the object in view. The same risks have to be encountered, to which the attacking columns sent forth to storm a hostile fortress are exposed. They may succeed in their object, though their ranks be swept down again and again by shot and shell. The same thing will happen when an attack is made by torpedo-boats. When the guns have opened fire, when the air is darkened by the smoke of gunpowder, when all is in confusion and the work of destruction is at his height,—the moment will then have arrived for giving the signal for an attack by the torpedo-boats, which up to the last moment must be kept in reserve, out of the range of fire.

Those who may be entrusted with the command of weapons of this character must concentrate their whole thought on the fulfilment of their mission of destruction, without expectation of returning in safety from the encounter.

The introduction of armour has given rise, to some extent, to the idea that, in attacks with torpedoes, as much care should be given to the protection of the torpedo-boat and its crew as to the destruction of the enemy. Such an opinion may tend to compromise the chances of success. It must be laid down as a first principle that the attack must be the main object.

However great may be the risk of losing the boats and their crews, it must be viewed by the weaker maritime Powers as an insignificant consideration, when compared with the great results which a successful encounter would ensure. These results are the destruction of the large armoured frigates with which the weak navies are unprovided. Hence the torpedo must be regarded as essentially the weapon which the weak man must use against the strong. *Revue Maritime.*

SEA-GOING TORPEDO VESSELS.

Admiral di San Bon.

Admiral di San Bon.

Speech at Spezzia.

On the occasion of a banquet given in his honour by his constituents at Spezzia, in December, 1873, M. di San Bon made the following remarks:—

With reference to torpedoes, I may tell you that we have in view the construction of a torpedo-boat, the engines for which were commenced some time ago. As soon as they are in a sufficiently advanced state we shall place the vessel upon the stocks, in order that she may be ready to receive them when completed.

The torpedo-boat will be able to traverse a distance of at least 600 or 700 miles, and will be provided with a sufficient number of torpedoes to effect the destruction of several large ironclads. She will be a good sea-boat, and will be constructed in such a manner as to enable her to contend with all weathers. With respect to the risk which the commander of such a vessel must run in bringing his torpedo into contact with a hostile ship, I do not hesitate to say that it will be far less than that which is ordinarily incurred on board an existing ironclad.

I am in a position to guarantee that by an entirely new system, the details of which it is not desirable to communicate, the successful management of the Whitehead torpedo becomes a certainty. As soon as our torpedo-boats are finished, they will be able, if they are tolerably fortunate, to sink two or three ironclads. It may of course happen that they will have the ill luck to be destroyed by the first shot of the enemy, though this is not very probable; but if they are successful they will be able to destroy more than one ironclad. In the meanwhile, in order that our officers and sailors may become accustomed to the proper use of this weapon, without fear, and that they may become familiar with the new system of working, which must not yet be publicly revealed, I have established a torpedo school.

RUSSIAN TORPEDO VESSELS.

Messrs. Yarrow are constructing a large torpedo-boat for the Russian Government, which will be capable of steaming from the Thames to St. Petersburg. It is built after the model of what is known as the 'Yarrow' type, being fitted with two funnels and a curved deck, and is provided with a modification of the plan for fighting the Whitehead already described. It measures 100 feet in length by 12½ feet in beam, and is propelled by a two-bladed screw, the shaft of which passes below the rudder, which is pivotted upon the propeller tube. This plan will secure the boat great rudder leverage; but in order to enable the boat to turn in her own length, and increase her manœuvring power at full speed, she is also provided with an auxiliary drop rudder forward, which can be worked in conjunction with the aft rudder. Her armament consists of six Whitehead torpedoes (two being in the guns ready for firing) of the ordinary 14-inch character, four of the Russian type, which are much larger than those employed in the English service. These are fired from two torpedo guns, or impulse tubes, built into the boat forward, and covered by a turtle-back deck, which not only protects the gear, but adds considerably to the seaworthiness of the craft. This turtle deck is raised at the after end, and slants forward to the level of the deck. The conning tower, whence the torpedoes are fought and the boat is steered, is immediately at the rear of the turtle, and has thus an unobstructed view. Boats of this new and formidable character are considered to possess much more offensive power than those of the 'Lightning' type, which are only provided with one torpedo ready for use, and a couple of spare ones, and in which the projectile and the discharging apparatus are in a most exposed position.

Times, April 13, 1880.

TORPEDO TENDERS.

Admiral Porter, U.S.N.

Admiral Porter, U.S.N.

Annual Report, October, 1871.

I would recommend that, besides several smaller torpedo-boats, built for coast defence, six, of a little more than 1,000 tons each, be constructed of iron for foreign service.

These should be able to keep the sea, under steam or sail, in all weather, and be provided with comfortable and well-ventilated quarters for officers and men.

The number I have stated would be few enough to build. They might be constructed with light draught of water, and perfect ventilation, for use in the rivers of China.

It will take at least three years to build these vessels, even if we commence them now. To construct them after a war has broken out would result as it did with some of the vessels built during the latter part of the rebellion; they were never even used, and will probably never be called into service.

Lieutenant Charles Campbell, R.N.

Lieutenant Charles Campbell, R.N.

Essay on Tactics in an action on the open sea with existing weapons. Honourably mentioned at the Royal United Service Institution in the competition for the Gold Medal, 1880.

I look upon the work of the line-of-battle ship in a general action at sea to be the effective discharge of her heavy artillery—the destruction of all that she can get to stand in her way, by using her ram; and the preserving of the general formation of the fleet as far as lies in her power. But, though she may not attack with torpedoes herself, there is no reason her boats should not. Every fighting ship should be fitted with two very fast steam-torpedo quarter-boats, each fitted for the use of the bow-pole torpedo, Harvey's towing torpedo, and Whitehead's fish torpedo. Their speed should reach, if possible, twelve knots. They should be fitted with lowering apparatus capable of lowering them at a speed of ten knots in ordinary weather, and they might be lowered by all ships of the fleet just as they came up

Lieutenant Charles Campbell, R.N.

with the enemy. Thus, with a fleet of eighteen ships you would have thirty-six small torpedo steamers down in an instant, dealing destruction on all wounded vessels of the enemy—getting under their bows, and discharging fish torpedoes at those going at a high speed, and dragging the towed torpedo under the bottom of any ship whose way was stopped by collision or otherwise. That these boats would run but little risk may easily be imagined, as the enemy themselves would be far too busily employed in preventing themselves from being rammed, in ramming, and firing heavy artillery, to be able to pay much attention to the small destructive torpedo-boats, who would be darting about in all directions.

Besides these quarter-boats, or in the case of their not being fitted as above, I think that every fighting line-of-battle ship should have a torpedo tender—a vessel of two to four hundred tons—in which nothing but speed, turning power, and torpedo fittings have been considered; the bow tube, the towing, and fish torpedoes would all be in readiness for use at a moment's notice. She should keep close to her line-of-battle ship, carefully keeping out of the line of fire and out of the way, watching her opportunity to dart out and use her offensive weapons, or get right in the way so as to cause the enemy's vessel to give a sheer, or run her down and entangle herself ready for the next line-of-battle ship to ram or the next tender to blow up. These tenders would be most useful in towing disabled vessels out of action, in assisting the look-out vessels when searching for the enemy, and also in rescuing and taking on board any of the small quarter torpedo-boats' crews which may have been swamped by the enemy's fire.

It may be urged in argument against this suggestion that these tenders would be constantly in the way of manœuvres; but I do not see that it is at all necessary that they should be so. I firmly believe that they would give most useful and valuable assistance in a general action. They should be armed with mitrailleuses, in case of their having to cope with anything the enemy might bring to assist in the working of their torpedoes.

As regards the defensive powers of the line-of-battle ship, it should be the duty of the small steamers to keep boats from coming too close, the ships themselves keeping at the highest possible speed.

Commander J. B. Hayes, R.N.

Naval Essay, 1878. 'Great Britain's Maritime Power.'

Commander J. B. Hayes, R.N.

It is presumed that all vessels will now carry steam launches as a protection against torpedo-boats. Great speed will not be wanted, but the object to be gained will be facility in lowering and hoisting at sea.

Lieutenant Eardley Wilmot, R.N.

Essay on 'Great Britain's Maritime Power,' *Journal,* Royal United Service Institution, vol. xxii.

Lieutenant Eardley Wilmot, R.N.

The Whitehead, as an offensive torpedo, stands above all others for several reasons, among which are:—

1. Its range of usefulness is great in comparison.
2. It has locomotion in itself.
3. Rapidity of movement.
4. Ability to retain a uniform depth and direction.
5. Its approach is unheralded by outward signs.

Under such circumstances, it simply takes the form of a submarine gun, with a shorter range of efficiency than the ordinary gun, but with the power, if successfully applied, of doing infinitely more damage. I would not, therefore, advocate the abolition of ships carrying guns for a fleet of torpedo-boats armed with this special weapon, but that the two should act in combination. Every large ship should carry this weapon, and a boat sufficiently large to be employed on torpedo-service, having a fair speed and seaworthy qualities. An increase in the size of the ordinary ship's launch would secure this.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION VIII.

THE 'POPOFFKA' TYPE.

THE 'POPOFFKA' TYPE.

'Engineering.'

But the circular ironclad may still prove to be the right model for our heavy fighting fleet, even though no such speed as 13 knots be attained or attempted. It is not clear that this high speed—which is about that of the 'Devastation'—is necessary, as we have often pointed out, and though the question is fairly open to argument it is possible that, to secure such advantages as the 'Popoffka' offers us, we might be content with less—say with 10 knots. If it be possible to build for the cost of the 'Devastation' two 'Popoffkas' of only the same armour and guns as the 'Admiral Popoff' carries, and of say 10 knots speed, it is hardly open to doubt which would be the most profitable way of spending the money. A hostile 'Devastation' could elude them, of course, but she could not fight them (or either of them, probably), and thus they would have at least the 'command of the seas.' The French fleet of old were nearly always better sailers than our ships, and for years were able to keep out of our way as they pleased. Yet so little did this answer their purpose that they offered a meeting at last, and were destroyed, and the same thing would almost certainly happen again. If not, it should be remembered that though the best thing to do with your enemy is to take him or sink him, the second best thing, and no bad substitute, is to make him run away. Speed may not be indispensable, however desirable, in a line-of-battle ship.

Commander Noel, R.N.

In order to have an efficient coast-defence fleet, we ought, in my opinion, to possess four circular ironclads of the first class (about 8,500 tons), for the Thames and South-coast ports; six circular ironclads of the second class (about 5,000 tons), to be stationed at other

ports in the United Kingdom; and thirty gunboats of the 'Comet' class divided along the coast, where most required. To these torpedo vessels may be added, when a really valuable type has been introduced.

Essay for 1876, 'On the Best Types of War-Vessels for the British Navy.'

Sir Edward J. Reed, K.C.B., M.P.

Sir E. J. Reed, K.C.B., M.P.

From a paper, 'Circular Ironclads,' read before the Royal United Service Institution, February 4, 1876.

In this country it must be acknowledged that the problem of producing armourclad vessels subject only to the conditions of 13 feet draught, 8 knots speed, thick armour, and heavy guns, has never been put by the administrators of the Navy to the constructors of the Navy. During the seven years that I filled the office of Chief Constructor of the Navy, the only light-draught armoured vessels that I was called upon to design were certain very small vessels, the breadth or beam of which was limited to a comparatively small amount, to make them fit for service on the inland waters of North America, and a vessel or two for colonial use, under conditions imposed by colonial requirements. The administrators of the Navy have usually considered—and for my part I have concurred with them—that the necessity for ships capable of performing service abroad is, in our Navy, so much more urgent than that for purely coast-defence vessels, that sea-going qualities at least sufficient to make the ships safe at sea, have been for the most part of primary importance. . . .

With reference to the performance of these circular coast-defence ironclads of Russia, I cannot, I fear, do much more than simply repeat what I wrote to the *Times* on the subject. As regards speed, only a low speed was required for the object in view, and with engines of 480 nominal horse-power, manufactured in Russia, a speed of 8½ knots has been obtained in the 'Novgorod.' She has steamed long distances at an average speed of 7½ knots, and when I was on board we easily averaged over 6½ knots, although the machinery was out of order, and much steam was wasted. I cannot give the indicated power developed, for we had not on board the means of determining it; 2,270 indicated horse-power has subsequently been given to me as the fullest power developed in this vessel. If we consider only the displacement of the vessel, this will no doubt be thought a large power to employ in obtaining a speed of only about 8 knots; but displacement only is a very delusive standard to judge by; the true standard is the offensive and defensive power of the vessel, and I do not believe any other vessel exists, equal to the

Sir E. J. Reed, K.C.B., M.P.

'Novgorod' in these respects, in which a like speed is obtained with like power. . . .

It was impossible to avoid observing how much more efficiently a vessel of this form is protected by her armour than is a vessel of the usual form. In ordinary ships, as you well know, great exposure results from pitching, from rolling, and from the alteration of wave hollows and crests along the ships' sides. . . .

From the first day of my connection with ironclad ships I felt the force of this consideration, and fondly hoped to carry the armour continually lower upon the sides of our ironclad frigates as we made progress in other ways. But in a service like the Royal Navy, and where the constructor is but a humble servant of the Admiralty in so many things, I never was able, I think, to get beyond the depth to which the armour of the 'Bellerophon' and the 'Hercules' was carried, and undoubtedly the length even of our shortest ships occasions so great a demand for armour that it has not been possible, consistently with other conditions which were thought more important, to carry the armour lower than it was carried in the vessels just named. . . .

In coming now to consider more generally the qualities of circular vessels, and especially of fast sea-going vessels, I think it right to say most distinctly that the great value which I attach to Admiral Popoff's labours in this connection, springs from the stimulus they exert in favour of reduced length and increased breadth in ironclads. The circular ships exhibit the limit of reduced length and increased breadth, and it is in this aspect that I wish to discuss the subject. I do not profess to be able to discuss it at all exhaustively; my investigations have not gone nearly far enough for this, and it is upon investigation only that strong opinions in such a matter as this should be based. To say that circular ships can, or even to suggest that they possibly may, have high speed given to them is a startling thing, for we all know that the resistance of such a form of ship must be very great indeed. We all know that great steam-power must be needed to overcome that resistance. Still, having come to plate our ships with very thick armour, and to carry tremendously heavy concentrated armaments, we have now to ask whether the adoption of ordinary forms and proportions does not entail upon us greater disadvantages than an increase of steam-power? In order to place the subject into due relation to the broad question of ironclad construction, I have to ask you to look at it from this new point of view. Hitherto the problem has been how best to armour-plate ships? The problem to which I now invite your attention is, how

best to adapt armour-plated fortresses for being sent to sea, and steaming there at sufficient speed. . . . *Sir E. J. Reed, K.C.B., M.P.*

I expect to have the general concurrence of thoughtful officers in saying that with armour already two feet thick in the 'Inflexible,' and a hull to carry it made larger than any previous ship except the 'Great Eastern,' it is time that we ceased to armour mere *ships*, and set about subordinating ship-shapeness and the use of sails to more momentous considerations. . . .

I think we may fairly say that for a sea-citadel, viewed as a citadel only, apart from other features, the circular form is best, because it requires a minimum amount of armour to protect a given area or volume; or, in other words, with a given amount of armour secures the greatest amount of buoyancy. For special purposes some modified form might be preferable, but speaking generally, the circular form is the best for floating armour to protect an included space, and also for giving that equal all-round command with your guns which is so desirable at sea. Starting then with this circular armoured citadel, and wishing to propel it at speed at sea, there are several ways in which we can deal with it.

1. We can put engine-power in it just as it stands, without modification; or,

2. We can build ends to it like those of an ordinary ship, protecting those ends by a belt of armour, as in the 'Bellerophon,' 'Hercules,' and many other ships; or,

3. We can build such ends to it, and protect the lower parts of them by an under-water deck of armour, as in the 'Inflexible'; or,

4. We can build around it an outer circle of thin iron, with a mere narrow belt of armour, analogous to the belt of ordinary ironclads; or,

5. We can build around it such an outer circle of thin iron, with an under-water deck of armour, analogous to that of the 'Inflexible,' or,

6. We can build short ends to it, with either belts or under-water armour decks, but of greatly reduced length as compared with the ends of ordinary ships of large beam. . . .

We may start, therefore, by saying that the circular ironclads have started with a much less proportion of steam power to citadel armour and guns than has usually been given to ironclads, and not with an enormously greater power as many persons have been too ready to suppose; and I must say that before resorting to the adoption of enormous ends, whether armoured or unarmoured, as a means of fining the lines, it is incumbent upon us to investigate how far it

Sir E. J. Reed, K.C.B., M.P.

is possible, or otherwise, to get high speed by merely increasing the power. As compared with ordinary forms, the power required to drive at high speed a circular ship of equal displacement will probably be from two to three times that required for an equal displacement, obtained on ordinary lines, or even more; but then displacement, as we have seen, is no sufficient basis, and the problem is to find out the true basis, and to proceed upon that.

I feel persuaded that the circular ship or citadel will hereafter be taken at least as the point of departure, if I may so speak, of our investigations. . . .

But there is one consideration which strongly tends, in my opinion, to favour the adoption of a short bow and stern in these vessels of extreme breadth, and that is, that the power of the vessel to steam against a head-sea would thereby be improved. . . .

But there are considerations, based upon the relations between wave periods and a ship's period of longitudinal oscillation, and of the changes in these relations effected by great speed, which point strongly to the value of some elongation of the form, especially at the bow, in order to facilitate steaming against a head-sea at high speed. I have had the advantage of a conversation on this subject with that very eminent investigator of naval science, Mr. Froude, and I think I may venture to say that he fully concurs with this view, and attaches to it even more importance than I at first did. With a comparatively small increase of armour, the circle may be developed into an approximately ship-shape form of short length and great breadth. . . .

I believe the circular form is itself quite compatible with high speed, and certainly it possesses very great and numerous advantages in other respects.

Admiral Sir Spencer Robinson, K.C.B.

Admiral Sir Spencer Robinson, K.C.B.

Discussion on Sir E. J. Reed's paper on 'Circular Ironclads.'

The question is certainly not, as some have put it, whether a circular ship is in all respects the very best possible vessel you could put upon the ocean to make long voyages, or to fight your actions against other ships of different classes; but it is whether this circular ship is not capable of defending places which no other ship could defend, and not only capable of doing so but capable of assaulting places that no other ship could assault? Those are questions that Mr. Reed, without any dogmatism, has put before you as matters deserving the investigation the Admiralty is prepared to give them, and I think as matters not deserving the ridicule of any person connected

with naval architecture and naval architects, and certainly not deserving the ridicule of any person who may some day or other be called upon to fight the battles of this country. Mr. Reed, having put before us the qualities of this circular ship and its adaptability for certain purposes of offence and defence, tells you that he sees no limit to its application, and that it is possible that hereafter the notorious and self-evident want of speed in these circular vessels might be cured by methods that he has not yet investigated, but that he has shown to any reasonable mind are capable of being investigated, and so that the problem may be ultimately solved. *Admiral Sir Spencer Robinson, K.C.B.*

Sir E. J. Reed, K.C.B.

I will ask the Institution to allow me to travel over some ground which I very lightly crossed a few weeks ago in a lecture at South Kensington, and to adduce some considerations which have not yet come in any other form before the public or professional men. I will presume that the days of mere 'armour-belted' ships are passing away; that however torpedoes may be best encountered or resisted, part of the change which they will force upon us is a much more extended and effectual preservation of the bottom of the ship from attack by means of armour plates; and that as an extreme view of a subject is often very instructive, we may with advantage assume for the moment that the whole bottom surface of the ship stands equally in need of defence. I will also ask Members to forgive me if the considerations which I am going to place before them are of a most elementary character; for it seems to me that in overcoming the enormous resistance which these circular citadels have to encounter—which, great as it is in the sea, is far greater in the dense and viscous ocean of prejudice through which they have to force their way—it is best at first to resort only to the most simple and conclusive considerations. . . . *Sir E. J. Reed, K.C.B., M.P.* Paper on 'Citadel Ships,' Institute of Naval Architects, March 22, 1877.

Now, most of those who come to speak of circular ships for the first time usually commence by saying, 'I can quite understand that the circular form may have some advantages as regards the flotation of great weights of armour and of guns, but it must be obvious to every one that when you have to put the vessel carrying this armour and these guns into motion—in other words, when you come to consider the *speed* of the ship—the circular form must be very unfavourable.' Now, I think I can show you by some simple considerations and by irrefragable proofs that the circular form is not by any means

Sir E. J. Reed, K.C.B., M.P. necessarily adverse to speed; but that, on the contrary, there are circumstances and conditions in which the circular form is very favourable to speed. I may even go so far as to say—and I will prove it to you—that in some cases you can obtain considerable speed with a circular ship when you could obtain no speed at all with a ship of the ordinary proportion of length to breadth.

These investigations led Sir Edward Reed to the following conclusions:—

1st, that economy of armour which, as armour increases in thickness, must press us more and more to reduce the armoured surface to the lowest possible amount; and, 2nd, to so form our armoured citadel that it will possess great stability in proportion to the amount of armour carried by it. I need hardly say that the circular form possesses both these advantages in the highest degree, because they both result directly from the fact that of all circumferences of given length the circular is that which embraces the largest area. That some ends of ship-shape character should be given to all sea-going ships at present for reducing resistance and otherwise improving sea-going qualities, I do not for a moment deny or doubt. But I maintain that there are many reasons why we should in proposing citadel ships well consider the circular form as our form of departure, and why we should be carefully on our guard against greatly encumbering the broad and short citadel with ends of much length and fineness. At any rate, such considerations press very much upon my mind as the thickness of armour increases—and we must remember that we are almost at the very beginning of armoured sea-citadels at present, the use of armour for naval defence having been in vogue but little more than twenty years—and I venture to think that as we make progress in the art of building such sea-citadels, we shall come more or less rapidly to form and entertain views very different from many of those which were expressed in this Institution last year. At the same time, this is a subject upon which, I venture to think, none of us are entitled to dogmatise, and I therefore have contented myself with throwing out for your consideration some of the facts and suggestions which are not at present recognised, but which greatly influence my own judgment on the matter.

'*Times.*'

Times. The great nautical experiment now in progress on the Clyde, under the auspices of the Russian Government, will command atten-

tion throughout the world. The adoption some years ago of the circular form for heavily-armoured ironclads by a distinguished Russian officer was a startling innovation, which but comparatively few persons have allowed themselves to regard impartially down even to the present day; but it was an innovation which found some degree of sanction in the fact that great advantages had been previously secured in our own Navy by the construction of short and broad armourclads. For his new adventure, however, Admiral Popoff may lay claim to absolute originality, the tendency of practice and experience in this and every other country possessing a steam marine being altogether adverse to the adoption of extreme breadth and extreme shortness in light unarmoured steamers. The new Imperial yacht does not, it is true, so closely resemble the circular ships as to be 'as broad as she is long,' but her length is only about one-and-a-half times her breadth, and these proportions are in far greater contrast with the proportions of our large and fast ocean-steamers than are those of a circular ironclad with the 'Bellerophon' or the 'Devastation.' There is probably no country besides Russia in which the proposal to build a fleet seagoing steam yacht more than 150 feet broad and less than 250 feet long would have been received with favour; but it was accepted there with alacrity and put promptly into course of execution, with the full approval of his Imperial Highness the Grand Duke Constantine, who is Lord High Admiral, and of his Majesty the Emperor, for whose service the vessel is designed. In noting these circumstances, we must remember that these high personages have had experience of the behaviour of the circular ironclads at sea, and it is in full view of their proved merits and demerits that they have sanctioned the application of similar principles to this armourless yacht, and have likewise appointed Admiral Popoff President of the Russian Council of Naval Construction. The launch of this new addition to the 'Popoffka' is a fitting occasion for offering some general remarks upon vessels of this description.

Times. 'Russian Circular Ironclads,' July 9, 1880.

Our ideas of an ironclad war machine for naval use are likely to be much influenced by the point of view which we take up in regarding it. As a matter of fact, ironclads have always been regarded in this country as ships bearing upon their sides and batteries a certain amount of iron armour for their protection, but in all other respects resembling more or less the ships with which we had become familiar long before armour was thought of. Even down to the present day we have furnished most of them with masts and sails to enable them to avail themselves of the wind as a propelling agent, and it is but a few days ago that an old and respected Member of the House of

Times. Commons, for the hundredth time, complained of their being less efficient under canvas than sailors naturally desired to see them. As long as ironclads of the first class are thus considered, all their great offensive, defensive, and steaming properties being regarded as of minor worth in comparison with efficiency under sail, we must probably be content with compromises and sacrifices from which a higher appreciation and a bolder use of steam and steel would set us free. It is in our power to consider the matter, as Admiral Popoff did, from quite a different standpoint, and to regard a first-class ironclad as a floating fortress, endowed by steam with locomotive powers, which we should no more think of propelling by means of the wind than we should think of discharging a Whitworth shell by means of a bow. Now, the most elementary science shows that the best form for giving flotation to such a fortress would be the circular form, and any departure made from this would tend to diminish the vessel's floating power, and, consequently, the weight and thickness of the armour with which it could be covered. On the other hand, the circular form would no doubt be adverse to speed, and could only be driven by means of excessive steam-power, and this would carry with it a large demand upon the flotation for supporting machinery and fuel, and a consequent proportionate reduction in the protecting armour. In either case a reduction of armour must therefore ensue from the necessity of giving motion and speed to the fortress, whether the circular form be departed from or not; but whether the loss would be greater from preserving the circular form and putting in the necessary steam-power, or from varying the form in order to make less steam-power suffice, it is not necessary here to determine. It would be for the scientific naval constructor, with all the conditions of each case before him, to decide between these competing elements; but it needs no scientific calculation to indicate that with armour 3 feet or 4 feet thick to be carried all over it would be utterly impossible to give to the fortress a highly elongated form with the fine lines of a ship. It seems likely, therefore, that in proportion as we break away from the old ideas associated with sailing ships, accept more freely modern conditions and capabilities, and resort to really invulnerable armour, we shall recede farther and farther from the forms and proportions of ordinary ironclads and approach nearer and nearer to the general idea of the 'Popoffka.' When once the development of the tremendous powers of steel, steam, and gunpowder are made the primary considerations by naval constructors of war engines, we shall probably witness changes far greater than any we have yet seen. For it is certainly true that progress in the construc-

tion of ironclad ships has been much checked and embarrassed by a too persistent desire to give our armoured fortresses the forms, proportions, and qualities of common ships. In our very first effort at ironclad construction — viz., the building of the 'Warrior' — we committed ourselves in a remarkable manner to this course. The 'Warrior' was a splendid frigate, but as an ironclad she was ridiculous, having her fighting fortress encumbered with large unarmoured ends, which would soon have been her ruin in action, and in which some of her vital mechanism (the steering gear, &c.) was left exposed to prompt destruction; while the fortified part of the ship, having the long, heavy, and easily penetrable ends to float, could carry even upon its limited battery such armour only as barely deserved to be called armour on account of its thinness. In the 'Inflexible' and all our latest constructions a similar principle has been reverted to, the citadel being burdened, and some think seriously endangered, by the addition of unarmoured ends twice the length of itself. In these ships the armour is, however, of great thickness, and the steering appliances most ingeniously and carefully protected; but still, viewing the construction as a first-class floating fortress, it is impossible to doubt that vastly too much has been sacrificed in the effort to conform to the old ideas of what a ship should be. That even circular batteries can both steam and behave well at sea, being more safe, comfortable, and under command there than ordinary ships, seems to have been demonstrated in the Black Sea; and if vessels of this extreme character can be so relied upon, obviously no fear of unseaworthiness need deter naval constructors from giving to their steaming fortresses any forms or proportions which either efficiency or judicious economy may be found to demand. *Times.*

It will be obvious that we are here advocating no special form of war ship as superior to all others, but are rather stating the grounds which lead us to suppose that there is no bar to improvement in respect of the shortening of our armour-clad constructions, if that course should really be found desirable under our modern conditions. There is one consideration, however, pointing in this direction of such paramount importance that we feel justified in mentioning it. If we should once come to the construction of the pure naval fighting citadel, so to speak, unembarrassed by the supposed necessity for preserving ship-like forms and arrangements, and should wholly surround the citadel with the protection of armour, we shall escape the necessity of returning to port for repair after every engagement. The ships of our Navy, especially those which have been constructed without even a belt of armour at the water line, whether liable to

Times. speedy total destruction in action or not, are beyond all question liable to almost instantaneous injury sufficient to necessitate repairs which cannot possibly be effected at sea, and consequently even the largest and costliest of them must be considered good for one fight only. How disastrous this may prove in war time every one can imagine for himself, and none can doubt that a fully armoured vessel would be enormously more valuable to the country. For it must be remembered that, while only a powerfully armed ship could hope to injure another vessel which was fully protected with thick armour, any fast ship whatever, carrying any armament whatever, is capable of driving back to port even the biggest ironclad afloat, if the latter be dependent upon the integrity of her unarmoured parts for her security or efficiency. It is not without good reason, therefore, that we avail ourselves of the present occasion for directing the public mind and the thoughts of the Government to the desirability of well considering whether there is not a wiser and better course open to us, at least in the case of the largest and most powerful ships, than that at present pursued.

In now leaving the question of armour-plated constructions and coming to that of ordinary fast steamers, we must look for any justification of the new Imperial yacht 'Livadia' to considerations of a wholly different kind. As a starting point, nevertheless, we may confidently assume that it is the extreme steadiness in heavy seas of circular vessels that has been accepted as the ordinary inducement to build this yacht. The repeated testimony of eye-witnesses, and of those who have made passages in the Black Sea 'Popoffka,' places the fact of their general steadiness beyond doubt. While in company with ordinary steamers which were rolling heavily, and making life on board of them torment for many hours and even days in succession, the circular vessels have continued steady almost beyond belief; and, after every allowance has been made for accidental conditions, this has been explainable only upon the assumption that their extraordinary form greatly favours steadiness. This view is certainly fully accepted by the Russian authorities, who necessarily know more than ourselves of the performances of their vessels. Neither of the circular ironclads has yet, however, been far out of the Black Sea, and Atlantic seas might prove more capable of causing them to roll than any yet encountered; moreover, as the yacht is of exceedingly light draught (only 6½ feet), and, therefore, floats in turbulent surface water, she may possible prove less steady than her predecessors. On the other hand, her breadth and general dimensions are far greater than theirs, and this may be found to more than correct the

effects of diminished draught. We shall be curious to learn how she behaves in heavy seas, and shall regard her ocean trials as promising results of the highest importance to the future of naval architecture. *Times.*

The next feature to be noted is the departure in this case from the purely circular form by the extension of a bow and stern. As the vessel is but 80 feet longer than she is broad, these extensions can only be about 40 feet each, and there is reason to believe that they were adopted less for the purpose of diminishing resistance than for another reason. That other reason is to be found in the fact that in a very short vessel driven by immense steam-power (10,500 indicated horse-power in this case) at a high speed against a head sea there would be developed a tendency to 'dive' which needs correction, and that tendency is best corrected by additional length. The late Mr. W. Froude pointed out this condition of things, and as Admiral Popoff's representative at Glasgow has stated that no advantage in point of speed was, in his opinion, to be expected from increase of length, it is safe to conclude that the form has been somewhat elongated in order to secure longitudinal steadiness under steam at sea rather than increase of speed. Nor, notwithstanding her additional length, will the movements of the ship under steam be devoid of grave interest, either in smooth water or in waves. The driving of a floating body of her extraordinary form through the water at a high speed by the exertion of immense power may possibly present to the eye changes of immersion and trim of an altogether unexampled character, the nature of which will be influenced by the future circumstance that the propelling forces will be applied chiefly below the bottom of the ship proper. When waves are encountered at high speed, and the speed of the on-coming waves is virtually added to that of the ship, the qualities of the 'Livadia' will probably be put to by far the most serious test that awaits them.

One question which most of our readers will very naturally be inclined to ask, we, in common with Admiral Popoff and his representatives, are not less naturally disinclined to answer. What speed, it will be asked, is expected from this very strange and remarkable vessel? We need hardly say that her special form and construction place her so entirely beyond the range alike of all formulæ and all experience that only those who conducted abroad the preliminary experiments upon models which preceded her design can presume to answer the question with any satisfaction, and they have carefully refrained from offering predictions. The only speed that appears to have been promised to the Emperor is that of 14 knots, and there

'Shah' is a much larger ship, her displacement (5,900 tons) exc that of the new yacht (3,900) by 2,000 tons, while the steam- developed in the 'Shah' was only 7,500 indicated horse-power, is 3,000 indicated horse-power less than that expected i 'Livadia.' The cross sections of the two ships are more nearly that of the ship being 986 square feet in area, and that 'Livadia' about 900 square feet, so that the respective canals, speak, which the two vessels excavate in the water when ste ahead differ in size by only about one-tenth. There is anoth much closer resemblance between the two ships which ver persons would have anticipated, probably, but which we find vestigation to actually exist. We refer to what is technically as the 'co-efficient of fineness,' but what may be more fami described as the proportion which the ship's immersed volume to the volume of a rectangular box which would exactly conta immersed hull. In the case of the 'Shah,' this proportion is one-half, and is very slightly in excess of one-half in the case new yacht. Now, the 'Shah' steamed 16·45 knots, say 16½ on the measured mile, with her 7,500 horse-power, and if the could reasonably be expected to achieve an equal performanc 10,500 horse-power ought to drive her, we find, at a speed of 19 knots per hour. A falling off in performance might be exp even in the 'Shah' with the increased application of power owi the rapid growth of resistance at very high rates of speed, so from 18 to 19 knots per hour may be assumed as the speed wh vessel of the 'Livadia's' size and power would attain if forme the 'Shah.' The margin which the designer of the yacht h

as only a 14-knot ship, she has a margin of much more than half her steam-power as a security against unwonted resistance. Large as this surplus of power is, the Russian authorities have done wisely in having it supplied; for while in any event it must add greatly to the steaming efficiency of the vessel, the application of so much propelling force to such a steamer will solve, in the most effectual manner, the great problem set before her constructors. And a very important problem it is, and one which will throw great light upon the still obscure question of resistance to ships—obscure, notwithstanding the recent labours of Froude, Rankine, and other investigators. They have successfully established a theory of resistance which is essentially modern, and which admits of three sources of resistance only—viz., that due to the friction of the water along the bottom; that due to the disturbance of the surface, or the formation of waves, caused by the onward motion of the hull; and (which is of minor moment) that due to the formation of eddies in the stern wake. It will be seen from this bare statement of the case that the new yacht has a far better chance of attaining a high speed than the philosophers of the last century could possibly have conceded to her under their theories of resistance, and it is not by any means extravagant to hope that those may be disappointed who consider it impossible to drive so broad a vessel fast. *Times.*

As regards the steering and manœuvring of such a vessel, there is no ground whatever for question, save such as may result from her extreme handiness. The circular ironclads steer perfectly well, although their ready responses to the helm and their tendency to forge bodily forward in any direction in which they may be moving render it absolutely necessary to handle the helm with careful regard to their extreme sensitiveness to their rudders. If this consideration be disregarded accidents may doubtless result; but the conditions of good steerage in very short ships must now be perfectly understood in the Russian Navy, and so important a vessel as this will not be entrusted to unpractised hands. The skill and readiness with which naval officers accustom themselves to the handling of extremely handy vessels was aptly illustrated last week at Portsmouth, where an officer of the torpedo-ship 'Vernon' acquired in a few minutes the art of manœuvring with perfect ease and safety a new boat engined with the wonderful steering screw propeller of Colonel Mallory, by the action of which a fast boat can be made to dart about in every direction with the celerity of a fish.

The trials of the 'Livadia' will solve several problems for the settlement of which the condition of steam navigation presses, and

Times. for solving which the Russian Government and its enterprising N
Constructor will, in any event, deserve the thanks of the publi
less than those of men of science. If the authors of this great
periment should have to undergo some disappointments, they are
least, likely to surpass the expectations of many who now desp
dently criticise their efforts. At the same time they may thoroug
rely upon the sympathy of all those who like to see men have
courage of their opinions in matters affecting the progress of
world.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION IX.

MISCELLANEOUS.

MISCELLANEOUS SUBJECTS.

HYDRAULIC PROPULSION.

Committee on Designs.

Committee on Designs.

The hydraulic method of propulsion deserves more attentio it has yet received.

Mr. Andrew Murray, C.B.

Mr. Andrew Murray, C.B.

In course of the discussion which followed the reading of a paper, on 'The True Economics of England's Naval Power,' by Captain J. H. Selwyn, before the Royal United Service Institution, February 20, 1871.

Having had much to do with the experiments with the hyd propeller to the extent to which they were carried out b Admiralty, I am glad of an opportunity of backing up what C Selwyn said with respect to it in combination with sail] I look upon the results that may yet be obtained from that respect as probably superior to any that have been obt from any other steam propeller in combination with wind. the hydraulic propeller the water is taken into the ship a proceeds, and immediately acquires the velocity of the ship, a carried with it, and it is then acted on by the centrifugal pu the interior, and driven out at a velocity in accordance with the of the engine. The velocity with which the water is driven ou from which the power of propulsion is obtained, is always in accor with the speed of the engine, and it appears to me that noth lost in the action of this propeller by the speed with whic vessel may be going under canvas at the time when it is set to to act in combination with the sails. That is not the case eithe the screw propeller or with the paddle-wheel.

I hold that with the hydraulic propeller, supposing that th is already going ten knots, she will get the whole advantage o power, the same as if starting and proceeding with that alor have advocated that view for a long time. I am sorry that th cumstances have been such, connected with the 'Waterwitch,'

have prevented the Admiralty considering it right to continue the experiments. More experiments are particularly wanted. We know nothing of the subject, we neither know whether to send out the water through a small orifice with a high velocity, or through a large orifice with a slower velocity. We know nothing of the form of the pump. *Mr. Andrew Murray, C.B.*

Admiral Ryder.

Admiral Ryder.

Russian ramming diagrams. Royal United Service Institution, 1874.

It would evidently be of enormous advantage if vessels could go astern as quickly, and turn as readily, as when going ahead, and deliver effective ramming blows from either end, without destroying their steering apparatus.

The turbine can do this: the propellers are on the side, the rudders can be sufficiently removed from the extremities.

A fast vessel that has charged from ahead and missed her blow accidentally, or, more probably, intentionally, can then, by reversing the turbine action, still keeping the engine at full speed, return on the track of her adversary (assumed to be a screw), and thus take the position all ramming vessels of great speed will aim at getting, viz. 'astern.'

This position will take the place of the 'weather gauge' of our ancestors in future actions.

Having taken the lead in every nautical invention for centuries, the credit of perfecting the turbine is, it seems, to be left in the hands of our competitors, and yet what does it claim? The turbine claims to act (*a*) independently of immersion in the water, and therefore of draught; whether the orifice is covered or above water, is a matter of indifference: (*b*) when under sail there is great economy in using the turbine as an auxiliary compared with the screw: (*c*) the propeller cannot be fouled: (*d*) it will pump out water if the ship leaks from shot-holes, &c.: and (*e*) fire can be put out by aid of the engine, which is an enormous pump: (*f*) the vessel can be stopped much more promptly, and turned in her own length. In fact, the turbine appears—if its advocates are to be believed—to possess all the qualifications of a perfect propeller for a war ship, and in the first attempt at comparative experiments, the 'Vixen' and 'Viper'—sister ships—went 9·1 knots and 9·3 knots; the 'Waterwitch' (turbine) 9·2 knots!!—a most remarkable success, since which she has been stationed at Devonport, and as yet has been sterile. No other turbine has been built by us. The Germans are building one at Stettin.

UNIFORMITY IN SPEED.

Vice-Admiral Sir Edward Inglefield, C.B.

Vice-Admiral Sir Edward Ingl'efield, C.B.

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But there is another point which appears to deserve considera I mean the homogeneity, or rather the want of homogeneity, in speed of vessels of our present day squadrons.

It will easily be understood by naval officers that this want w be seriously felt by a Commander-in-Chief desirous of pursuin enemy's fleet at his utmost speed.

Now, as an example, let us take the 8 hours' full-speed tri the Channel Squadron off Lisbon last autumn; then the 'Achi distanced the rest of the fleet, and had she been in pursuit of a fl enemy, would have brought them to action, unsupported by a si other vessel of the squadron.

This want of homogeneity (I can find no better term to sig my meaning) is fully appreciated by the French, who for the n part fit their ships with engines of sufficient power to ensur minimum speed greater than the average speed of a correspond number of our vessels of war.

To meet this want, some interesting experiments in towing w instituted by the Commander-in-Chief (Lord Clarence Paget) in Mediterranean Squadron whilst I was serving under his orders, an have here the tabulated form of these results. By them it will seen that his object was to establish the fact as to the power at disposal to bring all his squadron to a given point in the short space of time. This experiment was made by a comparison betwe the speeds obtained whilst the ships were under tow of each oth and it was based upon the consideration that thus all the ships wo be brought into action together, by reducing the speed of the faste and increasing that of the slowest vessel in the squadron. To quo the words of Lord Clarence Paget, who says: 'Our towing tri may be shortly stated to have resulted in a homogeneous speed various ships, all under steam, tied together, at something less th the mean of their united individual speeds, and at an expenditure coals of about the same ratio. The only possible disadvantage w the risk attending the operation, which I hold to be comparative *nil*, since, if the leading ship suddenly broke down, her momentu would be sufficient to sheer her clear of the others, cutting of cour the hawsers. However, risk or no risk, it would, on certain occasior when it was an object to bring our *whole* force to a point in tl smallest possible time, be a great gain. . . .'

The 'Victoria,' at full speed, not towing, would steam 100 knots in 50 minutes less time; 'Gibraltar,' 100 knots in 14 minutes less time; 'Cruiser,' 100 knots in 6 hours 28 minutes more time; expenditure of coal about the same. 'Prince Consort,' 100 knots in 1 hour 12 minutes less time; 'Royal Oak,' 100 knots in the same time as when in tow; 'Enterprise,' 100 knots in 2 hours 49 minutes more time; expenditure of coal about 10 tons less by towing. *Vice-Admiral Sir Edward Inglefield, C.B.*

FORM OF BOW.

Mr. Barnaby, C.B.

We have abandoned the plough bow, first, because there is no longer any armour supporting the stem, the armoured deck forms a much better base for the ram than the stem would; and, secondly, because it appears to be desirable to avoid the great heaping up of broken water which is inseparable from the plough bow. *Mr. Barnaby, C.B.* — Director Naval Construction to Controller, June 8, 1878.

HATCHWAYS. SUBDIVISIONS.

Captain Colomb, R.N.

I should decidedly carry up the combings of many hatchways to the main deck. *Captain Colomb, R.N.* — Prize Essay, 1878.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION X.

REPORT OF THE ADMIRALTY COMMITTEE ON DESIGNS FOR SHIPS OF WAR.

REPORT OF THE COMMITTEE ON DESIGNS FO SHIPS OF WAR.

Report of the Committee on Designs for Ships of War.

Admiralty, July 26, 1871.

The requirements of modern warfare having rendered it nece for the Lords Commissioners of the Admiralty to consider, a some cases adopt, various designs for ships of war of a novel char their Lordships determined to ask the advice and assistance special Committee, to whom certain designs were referred for opi and report. This Committee, under the presidency of Lord Duf was appointed on January 12, 1871. They reported as follows:-

The undersigned members of the Committee appointed by Lords Commissioners of the Admiralty to examine certain re designs for ships of war, have the honour to submit the follo Report.

The instructions issued by their Lordships for our guid required us to confine our attention to such designs and subjec have been specially referred to us, and to abstain from taking consideration any questions, whether of the new designs or impr appliances, which are not obviously or necessarily connected them.

The result of our investigation of the comparative safety of 'Captain' and 'Monarch,' and of the influence which the princi adopted in the design of the former vessel had upon her loss, communicated to their Lordships in our special report of March last.

Besides dealing with this question we were called upon to offe opinion upon the several classes of ships of war represented by following vessels, viz.:—

The 'Monarch';	The 'Cyclops';
The 'Invincible';	The 'Glatton';
The 'Devastation';	The 'Inconstant.'

As regards these classes, including as they do a very large por of the British Navy, we were instructed to advise their Lords whether, 'with reference to the present state of the science of n

architecture and the requirements of naval warfare, the principles which should regulate the form and type of war ships to be built for the service of this country are fully satisfied by these designs, with the improvements recommended in them, or whether any further modifications are desirable.

Report of the Committee on Designs for Ships of War.

In carrying out this part of our instructions we have adhered, as closely as possible, to the terms of the clause previously referred to, in which we desired to confine ourselves exclusively to the precise designs laid before us; but the requirements of modern naval warfare are so multifarious and so complex, that we found it impossible to judge how far they are satisfied by certain specified types without considering to what extent these types are supplemented by other classes of ships.

It was necessary also in each case to keep steadily in view the particular class of services which the ship is intended to perform, this being an essential element in considering the merits of its design.

It will thus be seen that, notwithstanding the limitation in our instructions, by which several very important lines of investigation, nearly allied to the subject-matter of our inquiry, have been closed to us, the task imposed upon us has been one of no little labour. It has involved the consideration of the principal problems which occupy the mind and test the ingenuity of the naval architect, and has included a minute review of most of the classes of war ships in Her Majesty's Navy. When it is remembered that the thorough investigation of any one of the numerous branches of this enquiry is an operation necessarily requiring close and long-continued attention, it will be seen that, within the brief period allotted to our labours, it was impossible to do more than deal with each topic in a very general manner. It is also to be observed that many of the data which we were compelled to assume have been as yet but imperfectly tested by experiment, while the rapid changes which warlike appliances are almost daily undergoing necessarily introduce a theoretical element into all investigations of this nature.

A perfect ship of war is a desideratum which has never yet been attained, and is now further than ever removed from our reach. Any near approach to perfection in one direction inevitably brings with it disadvantages in another.

From the time when ships of war first carried artillery, and were thus converted from mere vehicles for the transport of armed men into engines of war, naval architects have been compelled, in designing them, to content themselves with a more or less satisfactory compromise.

Report of the Committee on Designs for Ships of War.

The difficulty, always great, of bringing into harmony the conflicting features which are desirable in a ship of war, was much increased by the adoption of steam power throughout the Navy; the form of hull which was thought to be requisite for obtaining the best results under steam alone being very different from that most suitable for sailing.

When to this was added the still more serious embarrassment arising from the introduction of armour-plating, the problem presented to naval architects became one of extreme difficulty and complexity.

For some time, indeed, after the necessity of using armour-plating had been recognised, but before the penetrative power of artillery had reached its present stage of development, the question how to unite in one ship the power of sailing, steaming, and carrying both heavy guns and armour, although difficult, did not appear to be insoluble, and was met with remarkable ability, and a very large measure of success, by the Constructive Department of the Navy.

In the meantime, however, a rapid progressive increase in the power of artillery led to a corresponding augmentation in the thickness and weight of the armour borne by ships, until the point had been reached at which it became impossible to combine in one vessel all the qualities which it is desirable a ship of war should possess, consistently with the attainment of a very high degree of efficiency in any of the more important of them.

The necessity, in some cases at least, of altogether sacrificing some one desirable feature, in order that another may be secured in a higher degree than would otherwise be possible, was recognised by their Lordships when they adopted the design of the 'Devastation' class, in which the power of sailing was entirely given up in favour of that of carrying thick armour and very powerful guns—of moving under steam at a fair, although not very high speed—and, finally, of carrying a sufficient quantity of coal to admit of voyages across the Atlantic being made without the aid of sails.

In the 'Inconstant' class a compromise of a similar character, but in a different direction, had previously been sanctioned, the protection of armour being altogether abandoned in order to secure very high speed under steam, combined with as efficient sail power as could be attained without interference with the essential feature of great speed under steam alone.

Each of these types possesses valuable features which are totally wanting in the other. Each in our opinion meets a part of the requirements of modern warfare, and must (subject to modification and improvement) continue to be represented in the British Navy.

To endeavour to arrive at a conclusion on the abstract merits of either, regarded simply as a ship of war, without reference to the many and various duties which the Navy of this country is called upon to perform, would lead to no useful result. *Report of the Committee on Designs for Ships of War.*

Again, in our investigation of the merits of the 'Monarch,' it has been evident to us that, regarded as a first-class sea-going armoured ship of war, with large sail power, her place in the Navy is in a class to which, notwithstanding the difference in their armaments, the 'Hercules' and the 'Sultan' (which have not been referred to us) equally belong; and that the opinion we feel called upon to express with regard to the 'Monarch' must be applicable in a very great degree to those ships also.

Disregarding the smaller classes of sea-going vessels belonging to the Naval Service (such as despatch vessels, gun vessels, &c.), a simple and perhaps, under ordinary circumstances, a safe method by which the requirements of the British Navy may from time to time be estimated, is to watch carefully the progress of other nations in designing and constructing ships of war, and to take care that our own fleet shall be more than equal both in the number and power of its ships to that actually at the disposal of any other Power.

But having regard to the rapidly changing aspect of the long-vexed question of guns against armour, as well as to the essentially transitory character of our existence as a Committee, we are compelled to cast our thoughts into the future, and to found conclusions, not upon experience alone, but in some degree upon theory and conjecture. For the purpose of this enquiry, therefore, we are disposed to measure the naval forces of other nations less by the ships and guns which they at this moment possess, than by those which we have reason to think it is, or soon will be, in their power to obtain, and which any nation that may design to strike a serious blow at this country at sea, whether at home or abroad, will probably take care to procure before attempting to do so.

Hitherto the powers of offence, represented by artillery, and of defence, by armour, have advanced almost *pari passu*, sometimes one, sometimes the other, slightly in advance; but we appear now to be closely approaching a period when the gun will assert a final and definite superiority.

When the 'Devastation' was designed, there was reason to believe that armour such as hers (12-inch plates, besides backing) was impenetrable to the most powerful gun used by any nation. Since that time the adoption of improved gunpowder for heavy guns has so far increased the penetration of the 25-ton gun that, at close ranges, the

Report of the Committee on Designs for Ships of War.

'Devastation' can no longer be said to be impenetrable to the actually carried in the turrets of the 'Monarch.' Nor is thi The 'Devastation' herself is to carry guns of far greater p (35 tons) than those of the 'Monarch,' and we see no reason believe that the limit of weight and power in guns will even have been reached.

Sir William Armstrong, in an important letter which he addres to Lord Dufferin on March 3, and of which a copy is annexed, sa 'Even now the Elswick Company would not hesitate to accept ord for rifled guns of 14 inches calibre, throwing shot of half a ton wei with a charge of 2 cwt. of powder, and to pledge their reputation the success of the undertaking.' He adds, that 'there are g reasons for inferring that no thickness of iron less than 20 inch supported by a backing corresponding to that used in the "Hercule would have any chance of offering the required resistance' to such gun. Another very eminent authority, Sir Joseph Whitworth, the accompanying paper with which he has favoured us, says that is prepared to undertake to make a gun of 11-inch bore which sh penetrate armour 16 inches thick at 1,000 yards, and that, for p tection against a 13-inch bore gun, the armour would require to not less than 24 inches thick.

We see no reason to doubt that it is within the resources science to construct guns of the power described, whilst it is cert that no first-class sea-going ship of war of manageable size can made to carry *complete* armour protection of anything like 24 incl in thickness, nor do we feel at all confident that even this thickne if attained, would permanently continue to be impenetrable. remains, then, to consider whether, when these probabilities becor accomplished facts, ship armour will retain any value, or whether ought not rather to be abandoned as a mere costly encumbrance.

Sir William Armstrong, as will be seen on reference to his lett contemplates and recommends the reduction of armour-plating to minimum, or even its total abandonment. His opinion, and t grounds on which it is based, are entitled to great respect, and ha received our best and most careful consideration. But we have fou ourselves unable to arrive at the same conclusion.

After making every allowance for the disadvantages that atte the use of an enormous dead weight of very costly armour, whi after all is not absolutely impenetrable to certain special guns, cannot lose sight of the indisputable fact that in an action betwe an armour-clad and an unarmoured ship (assuming that they car guns of equal power) the former has, and must have, an immen

advantage in being able to penetrate the sides of her adversary at a distance at which she herself is impenetrable; and, further, in being able to use with effect those most destructive projectiles 'common' shells, which would fall harmless from her own armoured sides.

Report of the Committee on Designs for Ships of War.

Even assuming that absolute impenetrability to shot proves to be unattainable, it is still our opinion that the time has not come to throw off armour altogether, but that it is necessary that the first ranks of our ships of war should continue to carry armour of as great resisting power as possible.

Before quitting this part of our subject, we desire to remark that, although, as before pointed out, there are serious difficulties in the way of increasing to any very material extent the thickness of armour applied in the usual manner to sea-going ships, viz. in the form of a complete belt around the ship, from stern to stern, at the water-line, besides local protection for guns, men, &c., it is not by any means certain that some method may not be devised of securing the requisite reserve of buoyancy by other means than armour-plating. Were this accomplished, the area of the armour might be diminished, and its thickness increased in a corresponding degree. The ship would then comprise a very strongly plated central citadel, surrounded and supported by an unarmoured raft constructed on a cellular system, or containing some buoyant substance such as cork, which, without offering any material resistance to the passage of projectiles, would not be deprived of its buoyancy by penetration.

In the absence of any practical experience of the effect of large shells or of torpedoes upon such a structure as that which we have in view, it is impossible to say with confidence that the object aimed at would be thus attained, but if it were, consequences of so much importance and value would follow that we think it right to indicate this line of enquiry as worthy of experimental investigation.

Another mode in which it is possible that additional carrying power (and consequently the means of increasing the thickness of armour) may be obtained, is by an alteration in the form of the hull at and below the water-line.

An important investigation, which has for some time past been pursued by one of our colleagues, Mr. Froude, has, although not yet complete, led to the belief that the lines usually adopted for obtaining high speed under steam may perhaps prove to be actually less adapted to that purpose than a form which will admit of much greater weight being carried by a ship of equal length. In order to test this on a larger scale than has hitherto been within Mr. Froude's reach, their Lordships have approved of experiments being undertaken

ort of Com- er on igns ships War. to ascertain the actual resistance offered by the water to the pa of vessels of different forms and at various rates of speed. As t experiments will occupy some time, it is not in our power t more than refer to them as indicating one of the directions in w important advantages may be sought with a fair prospect of suc

The carrying power of ships may certainly be to some ex increased by the adoption of 'compound' engines into Her Maje service. We are aware that this modification of the ordinary ma engine has not escaped the notice of the Constructive Departn of the Navy, and that some few of Her Majesty's ships have bee fitted. But its use has recently become very general in the r cantile marine, and the weight of evidence in favour of the la economy of fuel thereby gained is, to our minds, overwhelming conclusive. It is unnecessary for us to say that in designing a s economy of fuel may mean either thicker armour, greater spee smaller and cheaper ship, or the power of moving under steam al for an increased period, according to the service which the ship intended to perform. We beg leave, therefore, earnestly to reco mend that the use of compound engines may be generally adopt in ships of war hereafter to be constructed, and applied, whenever can be done with due regard to economy and to the convenience the service, to those already built.

In designing engines of this kind, care should be taken diminish friction as far as practicable by attending to the balance forces upon the shaft. In applying them to ships of war attenti must also be paid to so disposing the parts as to keep the whole as low a level as possible.

Before proceeding to consider any particular types it seen desirable to introduce here a few remarks upon a subject of conside able importance, and one which is more or less applicable to ever ship of war.

It is a well-known fact that those peculiarities in the design of ship which result in what is termed 'great metacentric height,' an consequent stiffness under canvas, are amongst those which materiall tend to produce quick rolling and to make the ship uneasy in seaway.

Nothing is so detrimental as this to the accuracy of artillery fire which, in consequence of the reduction in the number and increas in the weight and cost of projectiles composing a broadside, has nov become of far greater importance than at any former period. Nava architects have been induced, therefore, to seek steadiness of plat form by diminishing, as far as safety would allow, the statical stabilit

and stiffness of the ship. In some recent instances (*e.g.*, the 'Inconstant' and the 'Invincible' class) this was carried to a degree which, together with an alteration in the distribution of weights during construction, has led to a considerable weight of ballast being placed on board these ships in order to correct the crankness so caused. *Report of the Committee on Designs for Ships of War.*

Steps have been taken to obviate this defect in the 'Blonde,' a sister ship to the 'Inconstant,' now building; and we have no doubt the same would be done to any ship of the 'Invincible' class which might now be designed.

But although experience has shown that in these instances the principle of giving up stiffness to obtain steadiness of gun platform was carried somewhat too far, it is much to be regretted that it should be necessary in any degree to abandon the very important object which the designers of those ships had in view, and if any means can be adopted by which steadiness of platform may be made to accompany great stability or stiffness, a most valuable result will have been achieved.

Here another inquiry of Mr. Froude's comes to our aid, and seems to point out the mode in which this combination may perhaps be secured. He has ascertained by experiment, so far as the result of the use of large models can be relied on, that bilge keels of greater depth than it has hitherto been customary to use, have an extraordinary effect in checking the rolling motion of ships. We are fully conscious of the caution to be used in assuming that results obtained with models will equally follow on a much larger scale, but the attention which Mr. Froude has paid to the mathematical investigation of the ratio which the one should bear to the other leads us to think that he has made out a strong *primâ facie* case, and we recommend his experiments, which are still in progress, to the attention of their Lordships, in order that the result if it should answer expectation may be applied to the benefit of the Navy.

We now proceed to state, as briefly as possible, our views with reference to each of the classes or types of war ships referred to us.

1. 'DEVASTATION' CLASS.

(*'Thunderer,' 'Devastation,' and 'Fury.'*)

From the information furnished to us by their Lordships' command, we learn that these ships were designed for service in European seas, including the Channel and the Mediterranean, the prospect of their being required to cross the Atlantic being also contemplated.

Report of the Committee on Designs for Ships of War

It was requisite, therefore, to render them capable of meeting weather in mid-ocean and of fighting an action there if neces With this object they have been provided with a half-raised armoured forecastle, which increases the freeboard, elsewhere 4 ft. 6 in., to 9 feet forward. In this respect the design of t ships departed from the form of previous breastwork turret sl to which in other respects it conformed. It was subseque proposed to add an unarmoured superstructure on either side of breastwork, thus increasing the freeboard amidships to the full hei of the breastwork deck.

As two of these ships (the 'Devastation' and 'Thunderer') w actually well advanced at the period of our appointment, we w desired by their Lordships to consider and report as early as possi whether this or any other practicable modification might be desiral

In our reply, dated the 11th of March last, we expressed opinion that the proposed superstructure was not necessary safety. The reasons upon which this opinion is founded are stat in that report and its enclosures, to which we beg leave to refer.

It is only necessary now to add, that although the angle vanishing stability (43 deg.) which the calculations of the Constructi Department show them to possess, is, as we have already reporte sufficient to ensure the safety of these ships as designed, neverthele in the construction of future ships we recommend, in order to me all varying conditions of distribution of weights, &c., that the angl of vanishing stability of large mastless sea-going ships should not b less than 50 deg.

We are unanimously of opinion that, subject to any improvement which further investigations in the directions to which we have al ready pointed may render possible, the 'Devastation' class represent in its broad features the first-class fighting ship of the immediat future. We are agreed, also, in thinking that some at least of th ships of this class ought to have armour as much more tha 12 inches in thickness as may be compatible with manageable dimen sions of hull In the case of ships not intended for distant servic a great deal may be done in this direction by reducing their coal carrying capacity far below that given to the 'Devastation.' Thi would not entail any loss of fighting efficiency.

Upon the question of the half-raised forecastle and of super structures in general, there is a good deal of difference of opinio amongst those gentlemen who have been good enough to favour u with the expression of their views.

Persons whose opinions are entitled to weight have expressed t

us their conviction that even with the 9-feet freeboard forward, which these ships actually possess, it will be impossible for them to be forced head to sea without being 'smothered.' This is a point which cannot possibly be decided in any other way than by actual trial. Experience will show how much weight is to be attached to the objection referred to, but if it should prove to be well founded, the defect may be remedied by raising the forecastle to a greater height.

In designing future ships of this class we would recommend that a larger reserve of armour-protected buoyancy should be obtained by increasing the height of the armour belt forward, which is at present only six inches above the water-line.

2. THE 'MONARCH.'

We now come to the 'Monarch,' regarded, in the terms of our instructions, 'as a first-class sea-going ship of war.'

Putting aside the 'Warrior,' 'Achilles,' 'Northumberland,' and others of the early armour-clad ships, built upon designs which, with all their undoubted merits, are not likely to be repeated, we would apply the term 'first-class sea-going ships of war' to the 'Hercules,' 'Monarch,' and 'Sultan' only, amongst the ships which are or have been actually commissioned in the British Navy.

An essential characteristic which these three ships have in common, and which offers the principal obstacle to any material increase in the thickness of their armour, is the possession of a full sail equipment. The only broad feature which distinguishes the 'Monarch' from the other two (besides a difference in the mode of distributing the armour, the minimum thickness on the side being greater and the maximum less in the former ship than in the others), is the fact that her principal armament consists of four 25-ton guns in two revolving turrets, instead of four 18-ton guns on each broadside.

In this respect the majority of our number are strongly of opinion that the 'Monarch,' as a fighting machine, is superior to the broadside ships. When very heavy guns are to be used the revolving turret affords greater facilities for training them accurately upon the object, and, in armour-clad ships (by admitting of the use of very small ports), gives far better protection both to the gunners and the gear than any other method hitherto adopted.

But it is unnecessary to pursue this much-disputed question. Enough has been said to show that when we recommend, as we feel

[illegible]

bound to do, that no more ships like the 'Monarch' should be l
we consider that our recommendation must be taken to includ
'Hercules' and 'Sultan,' notwithstanding the somewhat gr
armour protection at the water-line which those ships possess.
reasons which have led us to this conclusion may be very br
stated.

In view of the actual known power of existing guns, the arn
of the 'Monarch' is far too weak for a first-class fighting s
whilst her cost, both of construction and maintenance, together v
the large number of seamen which, owing to her great spread
canvas, she necessarily absorbs, forbid her being relegated into
lower rank.

We consider that the 'Monarch' has done, and may possibly h
continue to do, excellent service to this country, inasmuch as sh
probably at this moment a more formidable cruising ship of war th
any other nation possesses. Our objection to a repetition of l
model is that other Powers may, without difficulty, become possess
of ships both smaller and less costly than the 'Monarch,' but whi
nevertheless, she may be unable to face. She represents both
men and money, a larger portion of the British Navy than it
desirable, in our opinion, permanently to shut up in a fighti
machine so imperfect as a ship with 7 inches of armour must now l
regarded.

Admiral Stewart, Captain Hood, and Dr. Woolley, however, are
opinion that both the 'Monarch' and 'Hercules' types are capabl
of improvements which would entitle them to occupy an importan
place in the Navy of the future. They consider that it will alway
be necessary that this country should possess very powerful ironcla
ships, with a sufficient amount of sail power to enable them t
economise coal in proceeding to distant stations. The 'Monarch,
'Sultan,' and 'Hercules' are at present by far the most powerfu
rigged ocean-cruising ironclad ships in the world, and with certai
modifications in their sail power, with more powerful fire ahead, an
with lifting screws, they are of opinion that ships of these type
would in time of war be of very great value, especially in distant seas
where there would probably be great difficulty in sending mor
heavily armed mastless vessels.

It is with much hesitation and reluctance that a majority of ou
number have arrived at a contrary opinion. We all view with regret
what presents itself to the minds of most of us as the inevitabl
failure of the attempt to unite in one ship a very high degree o
offensive and defensive power with real efficiency under sail; and we

should unanimously hail as a most valuable acquisition, and as a triumph of naval architecture, a vessel in which these apparently irreconcileable elements should be combined. But at present we find ourselves compelled to regard the attainment of this very desirable object as an insoluble problem; and we believe that our transmarine possessions, and other important interests in distant parts of the world, will be more efficiently protected by the establishment, where requisite, of centres of naval power, from which vessels of the 'Devastation' class may operate, than by relying upon cruising ships of such limited fighting power as the 'Monarch.'

Report of the Committee on Designs for Ships of War.

We think, however, that a class of vessels in many respects resembling the 'Monarch,' although much smaller and less costly, ought to form part of the British Navy.

This brings us to

3. THE 'INVINCIBLE' CLASS.

This class may be said at present to comprise six ships, viz., the 'Audacious,' 'Vanguard,' 'Invincible,' and 'Iron Duke,' with twin screws, and the 'Swiftsure' and 'Triumph,' with single (lifting) screws and a somewhat greater draught of water. The tonnage of these ships ranges from about 3,700 to 3,900; displacement from 6,200 to 6,500 tons; draught of water 23 feet to 25 ft. 6 in.; and speed under steam from 13 to 14 knots.

They constitute a class of armour-clad cruising ships of war with large sail equipment, which, although not belonging to the very first rank, are powerful vessels both for offence and defence.

We believe that reasons of a similar character to those which, as we are informed, induced their Lordships to sanction the construction of these ships, must be expected at all times to exist and to require attention; and we are of opinion that, for the important services which they are likely to be called upon to perform, they, and more especially those with the single screw, are exceedingly well suited as regards displacement, speed under steam and under sail, as well as most of the qualities which constitute a handy and useful ship of war.

Any new ships of this class which may be built will be much improved by increasing the strength of the lower structure, as a precaution in case they should touch the ground. This, by lowering the centre of gravity, will assist in obviating the want of stiffness under canvas which has been observed in the ships already constructed. We would also recommend an alteration in the armament of future examples of this type of vessel. We do not propose any increase in the weight of armour carried by the 'Swiftsure,' but having

Report of the Committee on Designs for Ships of War.

regard to the very imperfect protection afforded by the armo the main and upper deck batteries, pierced as it is by many and uncovered openings, we suggest that its distribution shoul so modified as to include, above the belt, such an area only of arn plating as may be requisite to cover one turret containing two h guns with its base, turning gear, &c. The rest of the armai would consist of lighter guns, unprotected by armour, in numbers as may be found convenient. We consider it essential the power should exist of obtaining a direct bow fire in a line the keel from the turret guns. The bowsprit and rigging of ship should, therefore, be so arranged as to admit of the line of being cleared in case of necessity, with as little inconvenience delay as may be. The turret should be so placed with referenc the rigging generally as to secure as large an arc of training possible on either broadside.

This arrangement would admit of the armour being somew thicker than at present, but even if it were not the case, we shc still regard it as a great improvement.

The present armament of these ships consists of ten 12½- guns protected by armour, and four unprotected 64-pounders, arranged that in addition to broadside fire, direct fire in line w the keel can be delivered right ahead from two 12½-ton guns a two 64-pounders, and right astern from a similar number of gu This feature is regarded by Admiral Stewart, Captain Hood, and I Woolley as of so much importance that, looking to the fact that t bow attack is generally considered to be that which will probably adopted in future actions, and that no masted sea-going turret ves has as yet been constructed to deliver a right-ahead fire, they prefer t 'Invincible' class with the present arrangement of armament to th proposed by the majority of the Committee. They think these shi armed as they now are, would be more efficient as ocean cruise liable to be sent for the protection of our most distant colonies, tha if their armament consisted of two heavy guns mounted in one turr (which would be liable to be totally disabled if penetrated by a singl shell) and a number of lighter guns unprotected by armour, an therefore exposed to the full destructive effect of common shell wit their large bursting charges.

4. 'INCONSTANT' CLASS.

The 'Inconstant' and ships of her class, although entirely unprotected by armour, are, in our opinion, calculated to perform very valuable service. The object that has been aimed at in their design

has been to combine good sailing with the very highest steaming power. *Report of the Committee on Designs for Ships of War.*

In order to obtain the desired speed, it has been thought necessary to build these ships of large dimensions.

If the experiments before referred to on the resistance of water to the motion of ships should lead to the result which seems probable, the dimensions of future vessels of this class may perhaps be considerably reduced without loss of speed.

We are disposed in any case to attach a high value to the employment (principally for the protection of our commerce) of unarmoured ships having great speed under steam, but we beg leave to suggest that a subdivision of this class into two might be made with advantage: one to possess the whole, or nearly the whole, of the sail power of the 'Inconstant,' whilst the other might have a still higher speed under steam (perhaps 18 knots at the measured mile), with a considerably reduced spread of canvas and a larger supply of coal. The former of these subdivisions would, we apprehend, be best suited for employment in distant seas, and the latter for service nearer home.

In every description of unarmoured vessel the smallest dimensions, consistent with the attainment of the requisite speed, should be adopted; and the majority of our number consider that with this view, as well as to diminish the size of the mark offered to an enemy's fire, it would be wise to reduce the height of side in future vessels of this class, by placing the guns on an uncovered deck. We consider, further, that the smoke and splinters resulting from the explosion of large common shells, in the confined space between decks, will be much more destructive and demoralising than when the small shells burst in an uncovered battery. A considerable saving of weight and reduction in the height of side may be thus effected in ships designed on the scale of the 'Inconstant' or the 'Blonde.'

5. 'CYCLOPS' CLASS, AND 'GLATTON.'

The four ships now in course of construction which are represented by the 'Cyclops,' are, we are informed, intended for the defence of our coasts and harbours, and are almost exact reproductions of the 'Cerberus' and 'Magdala,' which vessels were especially designed, a few years ago, for the defence of the harbours of Melbourne and Bombay. The local conditions of service in those ports are very different from those which prevail upon the coast of the United Kingdom, and as it is with reference to the latter alone that we are called upon

[illegible] of these ships, it will be understood that [illegible] closely approach to their prototypes.

Soon after the commencement of our proceedings we were e[illegible] to give an early opinion upon these [illegible] already commenced, with especial reference [illegible] suggestion of the Construction Department, that they might [illegible] seaworthy by the addition of a superstructure ne[illegible] that proposed for the 'Devastation' class. In our re[illegible] dated the 22nd of March last, we recommended that the thickne[illegible] of the plating should be increased; that the watertight comp[illegible] should be further subdivided; and that the k[illegible] structure of the vessels should be considerably strengthened wi[illegible] their probable employment in shallow waters, where t[illegible] be laid ashore and left by the tide.

We further stated that, in the event of these vessels be[illegible] required to make an ocean passage, or to be employed on any ser[illegible] where they would be likely to encounter waves of a period exce[illegible] ten and a half seconds, an ample reserve of dynamical stabil[illegible] as well as the additional accommodation which might then be requi[illegible] could be obtained, although with a slight sacrifice of fighting effi[illegible]ency, by the addition of the suggested superstructure, but t[illegible] whilst employed solely for the defence of the coast, and expec[illegible] only to make passages from one port to another in favourable weatl[illegible] there appeared to be no necessity for making any such sacrifice.

In offering these recommendations, we explained that they [illegible]ferred only to the four ships actually under construction, and [illegible] which, therefore, the design admitted of a limited amount of revis[illegible] only. We now proceed to offer a few remarks upon the modificati[illegible] which we think it would be desirable to make in any new ship wh[illegible] may be designed for similar service.

The advantages which the 'Cyclops' possesses for service [illegible] shallow water are that she carries (for a ship of her limited displa[illegible]ment) a very powerful armament, and that although her armou[illegible] not sufficiently strong to render her impenetrable by guns of eq[illegible] or perhaps even somewhat less power than her own, her small drau[illegible] of water may enable her to take up positions on the coast where [illegible] will be unassailable by ships of superior power.

On the other hand, her very moderate speed would much crip[illegible] her movements in case of an attack being expected upon an uncert[illegible] point of our coast. We regard this as so serious a drawback to [illegible] utility of this class of vessel that we are disposed to advise tha[illegible] considerable sacrifice of other qualities should be made in fut[illegible] examples in order to obviate it.

As a powerful armament, thick armour, speed and light draught cannot be combined in one ship, although all are needed for the defence of the country, there is no alternative but to give the preponderance to each in its turn amongst different classes of ships which shall mutually supplement one another.

Report of the Committee on Designs for Ships of War.

We would recommend, therefore, that if Her Majesty's Government should think any more coast-defence turret ships requisite, one class should possess the limited armour of the 'Cyclops,' with as much greater speed as can be obtained, without any material increase of her draught of water, by sacrificing one of the turrets and a corresponding portion of the breastwork. As the suggested increase of speed would render her less stationary and more likely to be serviceable at sea, we would recommend the addition of such superstructure as may be requisite to make her perfectly seaworthy.

Captain Hood dissents from this recommendation. He thinks that these vessels will be far more efficient, for the service they are intended to perform, if they retain the armament they were designed to carry, viz., four 10-inch guns, mounted in two turrets, with a speed of 10 knots, than if the armament were reduced to two 10-inch guns in one turret, and the speed increased, looking to what he considers to be the probability of the entire armament being disabled by one shell penetrating the single turret. In this opinion he is supported by Dr. Woolley, Admiral Stewart, and another of our naval colleagues.

The class of ships now under consideration, supplemented by a sufficient number of smaller and more purely local vessels of the 'Staunch' and other classes, will, in our opinion, form a very valuable nucleus for a satisfactory system of home defence, provided they are supported, as we conceive they necessarily must be, by vessels whose power, both for attack and defence, is fully equal to that of the most formidable sea-going ships. Vessels not intended for service in distant seas need not carry a very large supply of coal, and the weight thus saved may be applied in adding to the thickness of the armour, increasing the speed, diminishing the draught of water, or in such other manner as may be thought expedient. No system of home defence can be regarded as complete unless ships of the power here indicated form part of it.

The 'Glatton,' notwithstanding the heavy guns and thick armour she carries, cannot be regarded as altogether fulfilling these conditions. A ship which is to carry more powerful guns than hers is already afloat, and although the curve of stability of the 'Glatton' is longer, and in so far more favourable to seaworthiness than that of the 'Cyclops,' it may reasonably be doubted whether she could be

ort of Committee on Designs of Ships of War.

relied on to proceed at all times and in all weathers to any s where her services might be required, even on our own coasts.

Having thus briefly stated our opinions upon the several clas of ships referred to us, we proceed to submit for their Lordshi consideration a few suggestions, which, although not exclusiv applicable to any of the special vessels under consideration, have, the course of our enquiry, impressed themselves upon our minds deserving of attention.

1. We recommend that all cabin fittings, linings, &c., in tl penetrable parts of every ship of war should be rendered incombu tible. The moisture sometimes observed on metal linings, partition and the like, and even on wood, is due to the surfaces upon which appears being at a lower temperature than the air in the neighbou hood, and cannot appear until the temperature of the solid is actuall lower than the dew point of the air. This may be remedied by pre cautions which shall, as far as possible, prevent the temperature c these external surfaces from ever sinking below the dew point. Tw pieces of thin sheet iron, with a thin layer of cork between them would make a practically incombustible bulkhead, and one whicl would be very suitable to prevent the deposition of moisture, inas much as the high non-conducting quality of cork in respect to heat would allow each metal surface always to assume very nearly the exact temperature of the air contiguous to it. This same quality will render it a very useful partition for protecting the cabins against the extremes of heat and cold.

2. In comparing the relative proportions of various classes of ships, and considering how far each is likely to be affected by such modifications in design as we think desirable, we have been struck by the very misleading and inaccurate measure of the real size and displacement of a vessel afforded by the common mode of classifying ships according to what is termed 'builders' measurement.' We observe that, in order to obtain the requisite displacement within the prescribed limits of builders' measurement, forms which are manifestly disadvantageous have not unfrequently been adopted. A similar objection attaches to 'nominal horse-power' as applied to marine engines. We beg leave to recommend that the use of these terms be discontinued, and that the mass of a ship be described by 'displacement' and the power of her engines by 'indicated horse-power.'

3. When iron ships are sheathed with wood and coppered, it is of great importance that the most rigorous precautions should be

taken to prevent metallic communication between the ironwork of the ship and the copper sheating; and the efficacy of the precautions taken with this view should be tested by a galvanometer. Care should be taken to guard against the setting up of any such communication either by lightning conductors, or by waste pipes or other metal work connected with the ship. The galvanic properties of any composite metal that may be substituted for copper sheating should be carefully investigated.

Report of the Committee on Designs for Ships of War.

4. It is desirable that every ship should be fitted with a simple and efficient apparatus for noting the exact trim of the vessel at sea, so as to enable the fastest water-line to be maintained according to draught of water, and a trustworthy continuous indicator of speed should be always available.

5. Our attention has been directed to the hydraulic method of propelling steamships, with reference especially to vessels of very light draught, and intended for service in waters which are so shallow as scarcely to afford sufficient immersion even for twin screws, or in which there is reason to apprehend that the screws are likely to be fouled by obstacles placed there for that purpose. Regarded in this light, we are of opinion that the system is deserving of a more thorough trial than it has yet received, and we beg leave to recommend the subject to their Lordships' consideration accordingly.

6. As it is very improbable that the fleet of any nation will ever consist of armour-clad ships alone, and it is obvious that the penetration of armour-plates is not the only work that may be required from the guns of a ship of war, we think that a composite armament of protected and unprotected guns will in some cases be desirable and highly advantageous. Occasions may arise on which a rapid and well-sustained fire may be of more importance than penetrative power.

7. The importance of ramming in future naval warfare is likely to be so great, that in designing armour-clad ships particular attention should, and we doubt not will, be paid to the best means of resisting it. If the cellular or raft system of construction, to which we have alluded in a former paragraph, should prove in other respects feasible, one, and that by no means the least, of its advantages will be found in the protection it will afford against the dangerous consequences of this mode of attack.

8. We have already stated our opinion that it is desirable, in designing large mastless sea-going ships, that the angle of vanishing stability should not be fixed at less than 50 deg. It is impossible to lay down a simple rule like this respecting the safe angle of vanishing stability for sailing ships or for the smaller classes of mastless

port of : Committee on Designs r Ships War.

vessels; but this angle may be judged of in each particular case the help of the principles laid down in the paper on the stability ships under canvas which Professor Rankine, one of our colleague has been good enough to prepare for our use.

9. In addition to the determination of the metacentre and cent of gravity which is now made for every ship added to the Navy, I recommend that the metacentric period and the rate of extinction still-water oscillations should in every case be determined by expe ment when a ship is ready for sea.

We think it right before concluding to place upon record o sense of the ready and courteous assistance which has invariably bee extended to us by the Controller of the Navy, and the importa department over which he presides. Any information we hav sought has been readily furnished, and every facility has bee afforded us in the progress of our inquiry. To Mr. Barnaby, wit whom, as Chief of the Constructive Branch, we have been in ver frequent communication, our thanks are especially due, not only fo the able, clear, and suggestive evidence which he has been given befor us, but for the untiring and laborious attention which he has paid amid his many onerous duties, to the frequent calls we have ha to make upon his time and patience. We have been much impresse by the knowledge and ability evinced by him and his colleagues i dealing with the various subjects on which we have had occasion t consult them, and we congratulate their Lordships upon the posses sion of so highly instructed and capable a body of officers.

We also desire to acknowledge the valuable aid rendered us b Mr. Hounson, one of their assistants, whose services have bee throughout at our disposal, and to whose scientific acquirements w have been indebted for the examination and elucidation of many o the difficult problems which necessarily arose in the course of suc an enquiry as that entrusted to us.

We regret that two of our colleagues, Admirals Elliot and Ryder differ in opinion from the rest of our body on so many and such im portant points, that they have felt themselves unable to affix thei signatures to this Report.

DUFFERIN AND CLANDEBOYE.	A. W. A. HOOD.
WILLIAM THOMSON.	JAMES G. GOODENOUGH.
G. PHIPPS HORNBY.	G. W. RENDEL.
WM. HOUSTON STEWART.	P. DENNY.
JOSEPH WOOLLEY.	GEO. P. BIDDER.
W. J. MAQUORN RANKINE.	T. LLOYD.
W. FROUDE.	C. PASLEY.

PAPER A. (*Accompanying Report.*)

To the Right Honourable Lord Dufferin.

Newcastle-upon-Tyne, April 12th, 1871.

MY LORD,—Having been requested by your Lordship to communicate to the Committee on Designs for Ships of War my views as to the future progress of artillery, and as to the penetration of shot fired, under different conditions, against armour-plates, I proceed to give the Committee my opinions on these subjects, and shall take the liberty of extending my remarks somewhat beyond the strict limits which a literal interpretation of the terms of your Lordship's request would seem to impose. *Report of the Committee on Designs for Ships of War.*

Up to the present time, the difficulty of resisting the bursting power exerted in guns has increased in the larger calibres in a higher degree than could be explained by the mere increase in the amount of the charge. Indentations of the bore, at the base of the shot, showed that a local concentration of pressure took place at that point in large guns; and, if the cause had remained undiscovered, we should probably have already reached the limit of attainable power in heavy ordnance; but recent investigations of the forces exerted by fired gunpowder have thrown full light upon the subject, and shown that these forces can be so regulated as to render practicable a great increase in the size of guns. According to recent experiments, the statical pressure exerted by gunpowder, when exploded in a vessel capable of resisting the full force of the gas, amounts to about 35 tons per square inch. If the interstitial spaces, incident to granular powder, were eliminated, by making the charge a solid block, accurately filling the resisting vessel, the pressure would be very considerably increased, but with any description of powder that could be practically used in large guns, 35, or at the utmost 40 tons per square inch, is the highest statical pressure that can be attributed to the charge. If the maximum pressure exerted by gunpowder never exceeded that limit, there would be no difficulty in making safe and efficient guns of any size that could, with any probability, ever be required; and, it may appear somewhat paradoxical that the charge should, in any case, give rise to a pressure exceeding that exerted in a close unyielding vessel. It is, however, consistent both with theory and observation, that it should do so. It is a familiar fact that when a gun is fired while the shot lies in the bore, at a considerable distance from the charge, a force is exerted at the base of the shot which generally either bursts or ex-

Report of the Committee on Designs for Ships of War.

pands the gun at that point. The explanation obviously is that th gas expends its velocity against the shot, and suffers a condensatio which enormously exalts the pressure at the place where it occur Now, if instead of there being vacant space between the shot and th charge, the whole length were to be occupied by powder, the sam sort of action would still take place, for the gas, first produced b the ignition in the rear, would rush forward, mixed with unburn powder, and would come into collision with the base of the shot thereby producing, in a greater or less degree, the same effect a before. If the gun were strong enough to resist this local and ab normal strain, a recoil of the gas would then take place, and a wav of pressure would run back against the breech, returning again with diminished energy to strike the shot in a more advanced position. Thus a series of oscillations would be set up producing local intensifications of pressure, without increasing the velocity of the projectile. Where the cartridge is very short, as it is in small guns, these waves of pressure have no appreciable existence, except when the shot is not rammed home; but in large guns, where the charge is necessarily of great length, they operate with such force as to cause indentations and other local injuries to the bore. Experiments have shown that these wave forces are greatest when the charge is ignited at either end, and when the powder used is of quick ignition and of fine grain. They are least when the charge is fired in the centre, and when the powder is of slow-burning quality, and so large in the grain as to allow the whole mass to be permeated by flame before the explosive force is fully developed. At present, with large guns, part of the powder is frequently blown out unexploded, and the gun is then said to be unable to burn more than a certain quantity of powder; but this could not happen with concurrent ignition of different parts of the charge, because each part would burn independently, and be in effect a separate charge of small dimensions. If every separate grain could be ignited identically at the same instant, the action would be perfect, for, in that case, the highest statical pressure would be attained, without any rushing of gas from one part of the chamber to another. The larger the charge the more necessary it is to effect the diffusion of flame; and if in larger guns than have yet been made, the object cannot be sufficiently accomplished by reducing the rate of combustion and increasing the interstitial spaces, we may resort to the expedient of flame ducts through the charge, or of simultaneous ignition by electric action, at several points of the cartridge. At all events, the cause of the disproportionate strains affecting large guns being now understood, there can be no question that a remedy will

be found, and the way will then be open to any increase in the size of guns that circumstances may demand. Even now, the Elswick Company would not hesitate to accept orders for rifled guns of 14 inches calibre, throwing shot of half a ton weight with a charge of two hundredweight of powder, and to pledge their reputation on the success of the undertaking.

Report of the Committee on Designs for Ships of War.

The thickness of armour-plate which such a gun could penetrate may, perhaps, be somewhat problematical; but there are good reasons for inferring that no thickness of iron less than 20 inches, supported by a backing corresponding to that used in the 'Hercules,' would have any chance of offering the required resistance. In the earlier experiments made on the penetration of armour-plates, it was found that the resistance varied approximately as the square of the thickness; but later trials, with much heavier plates than those previously used, have shown that this law does not continue to apply when the thickness is considerably increased. With plates ranging from 5 to 15 inches in thickness, the results appear to show that the resistance to penetration varies pretty nearly as the square root of the cube of the thickness. Considering the disadvantage of thickness, in regard to the quality of the iron, it is probable that still thicker plates will continue to show a diminishing resistance in relation to thickness; but, at all events, the most favourable supposition would be that the above rule will continue to hold good. Upon this assumption, the resistance of a 20-inch plate would be about four times that of an 8-inch plate, which requires for its penetration a shot possessing a *vis viva* of about 71 foot-tons per inch of circumference. Hence, a 20-inch plate may be presumed to require a *vis viva* of 284 foot-tons per inch for penetration. In this estimate no account is taken of backing; but as the *vis viva* of the shot from the 14-inch gun, to which I have referred, would, at short range, be equal to 340 tons per inch of circumference,[1] there would be a margin of 56 foot-tons available for overcoming the resistance of the backing. The data for estimating that resistance are less definite than those afforded in the case of plates, but it may fairly be inferred, from experimental facts, that 56 foot-tons per inch of circumference would be a sufficient force to pierce a backing similar to that of the 'Hercules,' after penetration of 20-inch armour; and it is difficult to conceive that backing of greater solidity and thickness than that of the 'Hercules' can ever be applied to ironclads.

[1] The penetrating power of a shot in foot-tons per inch of circumference $= \frac{W.v^2}{2g \times 2240 \times \pi d}$; W being taken in lbs., v and g in feet, and d in inches.

Report of the Committee on Designs for Ships of War.

the flat-headed form did possess some superiority in this respect, tl advantage would not, in my opinion, be sufficient to compensate fı the necessity of making the projectile of tempered steel, and of form which opposes greater resistance to the atmosphere, and is le favourable for direct penetration.

It is also claimed as an advantage for flat-headed projectiles, th they may be used with more effect than any other form for pen trating a ship's side below the water level, but the great resistanc which water opposes to the passage of a shot must always render i extremely difficult to use any form of projectile effectively for thi purpose. The extraordinary amount of this resistance was shown i the numerous experiments made to determine the degree of sensi bility which would cause a percussion shell to explode by strikin timber, and not explode by previously striking water, for it wa found that the latitude for adjustment between those limits is ver small, or, in other words, that the retarding power of water to shot at ordinary velocities, is not very greatly inferior to that of timber I may also mention, that the brass head of the 'pillar' fuse, a originally made, was frequently crushed by striking water, and I found it necessary to make it very thick to resist the blow. Considering, therefore, that the velocity of a shot would be exhausted by passing through very few yards of water, and also that all forms of projectiles, fired with elevation, ricochet from water when descending at angles of less than ten or twelve degrees from the surface, I see no reason for carrying armour to a greater depth below water than is now customary, or, if carried further, a rapid reduction of thickness should commence where the armour now ends. It appears to me that the only case in which this mode of attack could be practised with any probability of success would be with depressed guns, at extremely close quarters, but even then it would be a very critical matter to strike the water precisely at the point which would enable the shot to reach a vulnerable part of the ship without exhausting its force by too long a passage through the water; and I venture to say, that a cool exercise of judgment upon such a matter would be scarcely compatible with the hurry and excitement of very close fighting. When thus fired direct into water, the flat-headed shot shows less tendency to ricochet than other forms of projectiles; but, on the other hand, the flat form of head involves a more rapid diminution of velocity after entering the water than is incident to a pointed, or even to a rounded form. But, whatever may be the relative merits of different forms of head for acting beneath the water, I am of opinion that there are other modes of sub-aqueous attack (of which

I shall presently speak), so much superior to that afforded by artillery fire, that I attach but little importance to any difference there may be in this particular between one form of head and another.

Report of the Committee on Designs for Ships of War.

I have now to treat of the comparative destructive effect produced by solid shot and by shell when directed against ships, both armoured and unarmoured.

When a solid shot passes through an armour-plated target, it carries with it a quantity of material composing the target, and the thicker the target the greater is the quantity displaced. If the shot break in passing through, as it generally does when made of chilled iron, the fragments of the shot mix with the broken material of the target, and the combined mass is dashed into the space behind. A thin plate of iron without backing does not break the shot, and supplies the least quantity of fragmentary matter. Its penetration, therefore, by a shot would be attended by the minimum of destructive effect in a ship, while the maximum would be produced by the penetration of the greatest combined thickness of armour and backing which the shot could freely pierce. Hence it is evident that, unless impenetrability be *insured* by increase of thickness, the only result of the increase is to augment the destructive effect attending penetration.

Next, as to shells. When a percussion shell passes through a thin plate, it travels from ten to fifteen feet before it explodes, and, as its velocity is but little reduced by the resistance of the plate, and as the velocity of dispersion is greatly inferior to that of progression, the fragments form a cone which attains but little divergence in the small space which remains to be traversed before reaching the opposite side of the ship, where, in general, the crew would not be stationed. I conclude, therefore, that more damages would be done by the large mass of fragments driven into the ship by a solid shot passing through a thick armoured side, than by the fragments of the largest shell exploding by its passage through the thin iron side of an unarmoured ship. Not only would the quantity of broken material scattered in the ship be greater in the former case, but it would take effect on the fighting side of the ship, instead of the opposite side, where little harm could be done.

Shells, as well as shot, when made of steel or chilled iron, may be used against armour-plates, but the necessity of making them very thick, to withstand the shock, disqualifies them from carrying a large bursting charge, unless they be made of excessive length, in which case they are very apt to crush up on striking. The great resistance offered by armour causes the shell to burst much more

eport of e Committee on Designs r Ships f War.

quickly than when fired through thin plate, and consequently explosion generally takes place in the backing; but in the m experiments I have witnessed with shells fired against plated targ I have never seen any distinct effect caused by the explosive acti except where the charge was carried in the front of the shell. that case the explosion produces a considerable increase in the s of the hole through the backing; but when the charge is lodged, it generally is, in the rear of the shell, the explosion takes effect a backward direction, where there is nothing to act upon. I a aware that some rare cases are recorded of very considerable dama being done to the backing by the bursting of shells not carrying t charge in the head; but I believe that the exceptional effects pr duced in such cases are attributable to the shells having deviat from their course, and lodged obliquely in the backing before t explosion occurred. As to carrying the bursting charge in front, it impossible to adopt that plan without great sacrifice of penetrati power; and I am, therefore, led to believe that shells possess bu little advantage over shot for use against armour plates, while the have the serious disadvantage of being very liable to explode prema turely in the bore of the gun when fired with the heavy charge required for penetrating armoured ships. If shells are to be used a all for this purpose, they should be made of steel, because the smal capacity attainable in shells made of chilled iron, and their great liability to break by striking armour, render their explosive force very inconsiderable.

Common shells containing large bursting charges are, of course, harmless against ironclads. In fact, a plate of about an inch in thickness seems generally sufficient to break them; and, when they break, the charge explodes without violence, like loose powder. Much, therefore, may be done in mitigating the effects of these formidable projectiles by the use of plates of very moderate thickness entering into the construction of the ship. I have already referred to the probably overrated effect produced by the fragments of such shells bursting inside of an unarmoured ship; but it is also necessary to consider the suffocating action of the smoke from the shell, and the demoralisation of the crew by the crash of the explosion.

These effects would be enormously aggravated if the explosion took place between decks; and, for that reason, I think that in all unarmoured vessels the guns should be carried on open decks. Whether it would be practicable to separate the guns on broadside, by iron screens or traverses, I am unable to say; but if so, this

expedient would have the advantage of localising both the destructive and demoralising effects of these projectiles.

Report of the Committee on Designs for Ships of War.

There is yet another mode of attack, viz. that by torpedoes, which is beginning to assume great importance, and which it is absolutely necessary to consider in reference to future designs for ships of war. So long as torpedoes were merely fixtures, they were only applicable to defence; but now that motion has been given to them, they have become most formidable implements of attack. Moving torpedoes are as yet in their earliest infancy, and will, unquestionably, undergo a very great development. They may be regarded as a species of projectile, the range and efficiency of which will, in the natural course of improvement, be continually increasing. I see no limit to their power, for they may be charged with any quantity of the most violent fulminates, and in resisting them the heaviest ironclad has no advantage over a wholly unprotected vessel. Slow-moving ships will be their easiest prey, and ships with great speed will be the best adapted for using them. At present they may be divided into two classes—namely, those which derive their motion from a ship with which they are connected, as Harvey's otter torpedo. and those which are self-propelling, as Whitehead's torpedo. The latter is treated as a secret; but whatever its particular mode of operation may be, there is no difficulty in producing the same result by various mechanical combinations.

The foregoing considerations as to the present effects and probable future of guns, projectiles, and torpedoes, lead me to the conclusion that no practicable thickness of armour can be expected to secure invulnerability for any considerable length of time. At present, it is only the most recent of our armourclads that have any pretence to be considered invulnerable. All the earlier vessels, when built, had just as much claim to be so regarded as the strongest ships of the present day; yet they are now completely left behind, and are, in my opinion, much inferior to well-constructed unarmoured ships. I venture to ask, What reason have we to suppose that the powers of attack will not continue quickly to overtake the increased powers of resistance, which we are applying at great increase of cost, and at a great sacrifice of general efficiency? Every addition to the weight carried for defence must be attended with a diminution of armament and of speed, unless the size of the ship be increased in a very rapid proportion. A continual addition, therefore, to the thickness of the armour, involves either a continual reduction of offensive power, or such an increase in the size of the vessel, and its con-

Report of the Committee on Designs for Ships of War.

sequent cost, as must limit the production of sea-going ships war to a number inadequate for constituting an efficient Navy.

In my opinion, armour should be wholly abandoned for t defence of the guns, and, except to a very limited extent, I dou the expediency of using it even for the security of the ship. Whe armour can be applied for *deflecting* projectiles, as at the bow of ship, it would afford great protection without requiring to be ve heavy; but in other cases, where it must be of great thickness to l effective, I think its advantage is not adequate to the sacrifices involves. Watertight compartments would alone be available again torpedoes, and it appears to me they would also afford the be security against the effect of penetration by projectiles at or belo the water-line. If we were relieved from the dead weight of heav armour, the gain of flotation would afford the means of enormousl increasing the armament and speed of the vessel. Or, what woul be better still, we should be enabled to reduce the size, and increas the number of our ships, so that the loss of a single vessel should n longer be a national calamity, as at present. We could then hav comparatively small sea-going ships, with abundance of speed an heavily armed; and, happen what may, such vessels could never b out of date, for they would always be well adapted for the protection c commerce, for colonial service, and for the attack of flotillas carryin an invading force. It would be necessary to adhere to iron as th material of construction, and the plates composing the skin woul require to be considerably thicker than those used in ordinary ship-building, to prevent penetration by grape shot or steel projectile from Gatling guns. The armament of these vessels might includ one or two guns capable of piercing the heaviest armour, and the rest should be light, but wide in the bore, so as to throw large shells with moderate velocities. A mixture of guns on the Gatling principle would also be of great service against boat attacks, and for pouring streams of bullets through the portholes of an opposing ship. A vessel so constructed and armed would be a formidable antagonist for an ironclad, even in a duel of artillery, while for ramming, or for using torpedoes, her superior speed and handiness would give her great advantage over a heavily encumbered adversary. But we could afford to use these vessels in far greater numbers than ironclads; and whatever the result of a single combat might be, a combined attack of several such vessels upon one iron-plated ship would, in my judgment, be wholly irresistible.

I hope, therefore, I may be excused for expressing an opinion that swift vessels of iron, divided into numerous compartments, with

boilers and machinery below the water-level, and only very partially armoured, constitute the class of sea-going ships which it would be most prudent to build under the present prospect of the progress of artillery, and the science of attack.

Report of the Committee on Designs for Ships of War.

As regards harbour defence, I will merely remark, that I am in favour of small unarmoured gunboats, and vessels adapted for employing torpedoes as implements of attack.

I have the honour to be,

Your Lordship's obedient servant,

W. G. ARMSTRONG.

PAPER B. (*Accompanying Report.*)

Chorlton Street, Manchester, July 3, 1871.

SIR,—I beg to enclose my answers to the questions sent to me by the Committee on Designs for Ships of War.

I have the honour to be,

Your most obedient Servant,

JOSEPH WHITWORTH.

Colonel Pasley.

Questions addressed to Sir Joseph Whitworth, Bart.

1. What thickness of armour do you think will be necessary to resist the artillery of the immediate future?

Ans. I have no doubt, after what we have accomplished with my new breech-loading gun, that, with an 11-inch bore, armour 16 inches thick can be penetrated at 1,000 yards; indeed, I am prepared to undertake to do it, after first making a gun of 7-inch bore, which would penetrate an armour-plate 10 inches thick without backing.

2. What thickness of armour-plate, with the usual proportion of backing, inner skin, &c., do you think will succeed in keeping out the projectiles of the heaviest gun to which you now refer?

Ans. The sides of the ship with armour-plates 16 inches thick would be so punished with the 11-inch shell that I should use, that it would be necessary, supposing the armour to be such as I have seen hitherto used, to have the plates not less than 20 inches thick; and for protection against a 13-inch bore gun, which size has been adopted in the service, the armour would require to be not less than 24 inches thick. The difficulty of obtaining soundness in armour-

When high velocity is required and for long ranges, then projectiles should be from three to four diameters long. *Report of the Committee on Designs for Ships of War.*

I am aware that some of the advisers, both at the War Office and the Admiralty, are utterly opposed to these views; and there is a remarkable instance of it just now in the case of the 35-ton gun, which has been, I am informed, re-bored for the purpose of increasing the size of the bore, and this is being done at a time when the large bore Enfield rifle is being supplanted by the small bore recommended by me at the close of my experiments in 1856. In both small arms and guns, whatever be the size, the same principles are involved.

Should this country unfortunately be engaged in war, it is fearful to contemplate what will happen if slow powder and short projectiles with slow rotation are persisted in; for other nations are becoming alive to the importance of having the most powerful guns, whatever may be the size of bore.

6. Have you considered the question of the application of the breech-loading principle to heavy guns, and if so, with what result?

Ans. I have; and the gun referred to in my answer to question No. 1 is a breech-loading gun, the principle of which admits of being applied to guns of the largest size.

JOSEPH WHITWORTH.

Chorlton Street, Manchester, July 3, 1871.

OPINIONS ON NAVAL CONSTRUCTION FOR WAR.

SECTION XI.

PAPERS AND PARLIAMENTARY SPEECHES ON DESIGNS FOR SHIPS OF WAR.

PARLIAMENTARY SPEECHES.

Speech in the House of Commons, May 8, 1876.

NAVY—SHIPS OF WAR.

Mr. T. Brassey.

From Hansard's 'Parliamentary Debates,' vol. ccxxix.

Mr. T. Brassey, in rising to move the following resolution 'That this House, while approving the programme of work on ironclad ships for the ensuing financial year, is of opinion that the present is a fitting opportunity for reviewing our shipbuilding policy and the resources of the Mercantile Marine for naval purposes; and this House is further of opinion that this inquiry should be held by a Royal Commission,' said: The Resolution I am about to move is drawn in terms which cannot be regarded as unfriendly to the Government. I regret the large expenditure on unarmoured ships, which the right hon. gentleman the First Lord of the Admiralty has hitherto refused to recognise as forming part of the effective strength of the Navy; but I am not aware that the designs for the ironclads now in construction have been disapproved by any competent critics. Having disclaimed any attention to criticise the ships at present being constructed, still less am I disposed to speak unfavourably of the designs approved by the late Government.

Arguments for Commission on naval designs.

Turning from the past and present to the future, I may remind the House that it was stated by the First Lord of the Admiralty, in his speech on moving the Navy Estimates, that it had been decided not to lay down any new ironclads during the ensuing financial year. I do not accuse the Admiralty of unnecessary hesitation in coming to a decision on the infinitely vexed question of naval construction; but, if no new ships are to be laid down, it cannot be urged that our shipbuilding will be delayed by further inquiry. It may be said, however, that the Department is at least as competent an authority on shipbuilding questions as any Royal Commission that could be appointed. I gladly acknowledge that the present Naval Lords, if they were not in office, would constitute a most able Commission. But my fear is that they have no leisure to investigate new problems

of armament, tactics, and construction. The hon. gentleman the Member for the Tower Hamlets (Mr. Samuda), in seconding a similar motion by the hon. Member for Lincoln (Mr. Seely), in 1868, said, as I think, truly, that—'When a great policy had been inaugurated, he could well understand that a Department of the State might efficiently carry it out; but it was unlikely that such a policy could be initiated by a Government Department.'—[3 *Hansard*, CXCIII. 1118.] *Mr. T. Brassey.*

Mr. Childers. In the same debate the right hon. gentleman the Member for Pontefract (Mr. Childers) said: 'That he could at the same time have wished that the noble Lord (Lord Henry Lennox) had been able to lay before the House some plan which, without diminishing the responsibility of the constructive department of the Admiralty, or diminishing its responsibility for all that was done under its superintendence, would give it the advantage of a certain amount of scientific investigation and advice.'—[*Ibid.* 1139.]

Conflict of opinion. The controversy as to the continued use of side-armour must naturally arouse the greatest anxiety in the country. It is said that unless armour be strong enough to keep out shells, it is worse than useless; and armour more or less impenetrable, even when limited to vital places, involves a large addition to the cost, and an increase of dimensions, tending to diminish that mobility, which is of the last importance, if, as Admiral Jurien de la Gravière predicts, ships will fight in the future with the rams alone. In our Navy there is an almost hopeless conflict of opinion. Captain Noel insists that excessive top-weight should be avoided. On the other hand, I am assured, in an able letter from an Admiral in a high command, that our men would have no chance if they had to contend with heavy guns, protected by a turret, and therefore fired with confidence and precision. The painful uncertainty in which we are placed in this country is shared by every maritime Power. In Russia, attention is being directed chiefly to the circular ironclads, the 'Popoffkas,' which are intended solely for coast defence. In Germany, it has been decided to lay down no more ironclads at present. M. Dislère, one of the constructors of the French Navy, says that the progress made by artillery has rendered it useless to retain armour for ocean-going cruisers. The views of M. Dislère are borne out by the passing events in naval construction. The 'Inflexible,' which has just been launched, is protected by 18-inch armour, and yet a target, representing the strongest portion of the armour of the 'Inflexible,' was penetrated a few months ago at 1,800 metres by a Krupp gun. While, however, we find an eminent French authority announcing that armour will shortly be laid aside, in his annual report, published

Mr. T. Brassey. last December, Admiral Porter says that the aim of the United States should be, in making changes, to resist the shot from the 12-inch 35-ton, which at 200 yards perforates 15 inches of solid wrought iron.

I do not pretend to offer an opinion of my own. When, however, we observe such a wide difference of view, it is our duty, as representatives of the taxpayers, to take care that these subjects are thoroughly investigated before we commit ourselves to large ships, which may be condemned as obsolete before they are completed.

Torpedo. In the interval which has elapsed since our shipbuilding policy was last reviewed by the Admiralty Committee on Designs, great progress has been made in perfecting offensive torpedoes. Many authorities declare that the most effectual defence against the torpedo is to be found in further developments of the cellular system of construction. According to Mr. Barnaby, on the other hand, it is idle to attempt to form the bottom of a ship strong enough to resist a fair blow from a powerful torpedo. Each costly ironclad should be defended against the torpedo and the ram by a number of small unarmoured vessels. But how are you to keep such a flotilla together? If our ironclads are to be attended by a cloud of skirmishers, they cannot venture far from their base of operations. Great coal-carrying capacity will no longer be necessary, and the high freeboard and other features of a sea-going ship may be materially reduced.

Examples of small ironclads. The motion I originally placed on the paper contained a recommendation that designs for various types of fighting vessels should be invited from private shipbuilders. The hon. gentleman the Member for Pembroke (Mr. E. J. Reed) has recently constructed for the Chilian Navy two vessels, each of 2,000 tons, armed with six 12-ton guns, protected by armour of 8 and 9 inches. Messrs. Rennie have built two gunboats for the Peruvian Government, little larger than the gunboats of our 'Staunch' type, but carrying 26-ton instead of 18-ton guns. Mr. Mackrow has recently designed the 'Vasco de Gama' for the Portuguese Government, which vessel carries two 18-ton guns, protected by a circular breastwork, armoured with 10-inch armour. The ship carries in addition one 6½-ton gun, and two 40-pounders, and has, I believe, been built for 100,000*l.* These examples suggest the expediency of following the precedent of 1867, when six of our most eminent firms were invited to submit competitive designs. Having regard to the danger to which the most powerful ships are exposed when attacked by the ram or torpedo, I should like to fix the limit of cost at 150,000*l.*, or even 100,000*l.* A perfect ship could not be built for such a sum; but

the attempt to unite in a single vessel every quality can only end in an unsatisfactory compromise. On a former occasion, when a similar competition took place, Sir Spencer Robinson and the hon. gentleman the Member for Pembroke were called upon to decide between the respective merits of the various proposals. The anomaly of this position was pointed out by Sir Spencer Robinson. *Mr. T. Brassey.*

Mercantile auxiliaries. I have thus far confined my allusions to the fighting Navy, but the naval resources of this country are not limited to the fleet especially constructed for war. The latest returns show that, in our Mercantile Marine, we have 419 steamers of 1,200 tons register and upwards. The extraordinary regularity of the passages made between Queenstown and New York is sufficient evidence of the steaming and coal-carrying capabilities of these ships, and the torpedo provides the means of defending them against the most powerful vessels of war. It therefore makes them a source of great naval strength. The owners of ocean-going steamers should be encouraged by judicious subsidies to build their ships of such a type that they could be converted, if necessary, into armed cruisers. This object can only be attained by making arrangements beforehand, when the designs are being prepared.

Precedents for an inquiry into shipbuilding policy. Numerous precedents might be cited of independent inquiry, by Commissions and Committees, into the condition of the Navy. It may not be equally widely known that a Commission, precisely similar to that which I propose, has recently been authorised by the United States House of Representatives. This Commission is to consider the great changes which have taken place of late years in naval warfare, and to recommend the best type of ship to meet these changes. They are to report on the whole subject and to enable Congress to consider intelligently, and to legislate upon, naval affairs in all their branches. The last is precisely the object I have in view. Under our Parliamentary system, it is essential that every Department of the Government should carry with it the approval of the public, even in matters of administrative detail. There is no alternative, therefore, for the Admiralty, but to satisfy the country that the expenditure they propose is necessary, that their designs for ships are well-considered, and that everything that it is practicable to do is being done to make the great resources of the country available as a reserve for the Navy, and so to diminish, as far as may be, the cost of our standing force in time of peace. The Report of the proposed Commission should be an invaluable document in the hands of the First Lord in pleading with Parliament on behalf of the Navy. It will not be necessary to make disclosures on points of

Mr. T. Brassey.

detail. In Parliament we want only that general information which will enable us to determine whether or not armour should be retained. We want advice as to the relative value of armoured and unarmoured ships, and as to the necessity or otherwise of building unarmoured ships of the vast dimensions of the 'Inconstant' or the 'Raleigh.' Thus far I have referred to the different modes in which money may be spent to strengthen the Navy. May we not venture, however, to hope that the Commission might be able to suggest economies in other directions? I noticed only the other day that 23,000*l.* had been spent in repairing the 'Salamis.' Can it be supposed that any private shipowner would have allowed such a sum as I have named to be spent in repairing a despatch boat of 835 tons? Admiral Porter has suggested in his last Report that iron cruisers should be built for the United States Navy, and kept on the stocks until the outbreak of a war. In this way all waste from wear and tear and dry-rot would be avoided. It may be possible to adopt the proposal of Admiral Porter with considerable advantage for the British Navy. In conclusion, assuming that such an inquiry as I have suggested were to be ordered, the question is whether it should be conducted by a Committee or a Commission. A Commission is to be preferred as being more independent. It may be that the Report would be wholly in favour of the designs submitted by the Admiralty. If such were the result, it would be eminently gratifying, both to the Constructor's department and to the public. If, on the other hand, the result should be that some suggestions were obtained which had not hitherto been adopted by the Admiralty, that again would be valuable, as tending to make our Navy stronger and more efficient than before.

Speech in the House of Commons, March 11, 1878.

Mr. T. Brassey.

From Hansard's 'Parliamentary Debates,' vol. ccxxxviii. Navy Designs of Ships of War.

Mr. T. Brassey: In seconding the motion of the Honourable Member for Lincoln (Mr. Seely), I wish to explain that, while I give my hearty support to his proposal, I see no cause for general dissatisfaction with our Navy. The zeal and ability displayed throughout the recent crisis of preparation for war, in the fleet, at the Admiralty, and the dockyards, have been such as to disarm criticism. But though I gladly acknowledge that we possess a fleet in which the country may justly take a pride, I venture to think that, with more consideration and forethought in our naval administration, we might have done better. I confidently believe that a searching Parliamentary inquiry at the present juncture would be of great assistance

in framing a policy for the shipbuilding of the immediate future. I need not enter on a long review of our past naval history in order to show that such an inquiry is desirable. In former times our ships were generally good in workmanship, though often obsolete in design.

Mr. T. Brassey.

Instances of misapplication of expenditure.

In a speech delivered in the House of Commons in 1863, Mr. Cobden criticised sharply the hesitation of the Admiralty to adopt improvements in the design and armament of ships of war. During the last eight years, he stated, thirty millions had been spent on wooden ships which were useless for war. He referred to the speech of Sir John Pakington, in introducing the Navy Estimates for 1859, in which he said that the French had gained upon us in the matter of screw ships, by converting their sailing ships, while we had been building them. In 1852, the English Navy had 299 sailing ships, the French 258. In 1858 the English had 296 and the French Navy 114.

The result of the hesitation so severely commented upon by Mr. Cobden was painfully apparent at the outbreak of the Crimean war. The French sent two screw-liners, the 'Charlemagne' and the 'Napoléon,' to Besika Bay, while we could only send one vessel, the 'Sanspareil,' of the same type, but with insufficient steam-power. In the first effort to send the fleet through the Dardanelles the French succeeded and we failed. It was only in 1859, when the 'Gloire' was on the point of being launched, that Sir John Pakington decided to construct the 'Warrior.'

Argument for moderate dimensions.

Our later ships, though admirable examples of naval architecture in their several types, are almost exclusively adapted for ocean warfare. No one will complain that we have too many first-class ships, but we have no in-shore squadron worthy of the name. We are conspicuously deficient in ships adapted for attacks on forts and batteries. We have been warned of our shortcomings in this respect by Sir Thomas Symonds, and other eminent officers, but we have neglected their advice. All our recent ships have been of the largest dimensions; and, as an inevitable consequence, the additions to the fleet have been lamentably few. In the five years ending March 31, 1879, only seven ironclads will have been added to the Navy, and of those five only will have been built in Her Majesty's dockyards. The cost of our ironclads has advanced in proportion to their tonnage. The 'Inflexible' is estimated to cost 460,000*l.* It seems a strange fatality that the design for our largest and costliest ship should have given rise to a controversy of unprecedented warmth. I shall not enter now upon a discussion which will more properly be

Mr. T. Brassey.

raised on the motion of the noble Lord the Member for Chichester. It may be questioned whether the increase in fighting power is proportionate to the increase in the cost of the later ships. In comparing the 'Dreadnought' with the 'Devastation,' M. Dislère, the eminent French naval constructor, observes that, in order to secure a slight increase in armour and armament the displacement has been enlarged from 9,190 to 10,900 tons, an augmentation of 1,710 tons, involving an addition of 80,000*l.* to the cost, and an addition of 33 feet to the length. 'How,' he asks, 'will such enormous masses be manœuvred in the confusion of a naval engagement? How will the ram, the most effective weapon, be used, to the best advantage?' These are questions on which the battles of the future may teach some unexpected lessons. I might quote opinions to the same effect from the separate report of Admirals Elliot and Ryder as members of the Committee on Designs for Ships of War, and from many other officers. There is reason to fear that our shipbuilding policy is conceived too much under the influence of a spirit of international rivalry. The action of the British Government even in departmental business is controlled and sometimes thwarted by public opinion. Professional judgment is too readily surrendered to popular ideas. Sensational ships are built to gratify the public; and the popular view of these subjects is derived from experimental firing at targets, or from trials over the measured mile, and not from any experience or conception of the practical conditions of naval warfare.

Argument against extreme calibres.

The same tendency to the sensational which is observable in the designs for ships is exhibited in their armament. When it is remembered how small a percentage of shot can possibly take effect when the combatants are moving at high speed, it becomes a question how far we ought to go in the introduction of 80-ton or even 38-ton guns as the principal, in some cases the only, armament of our ships. The increase in calibre involves not only a reduction in the number of guns, but a reduction in the rate of firing, which may prove a serious disadvantage in a naval action. The Committee on Designs recommended the general adoption of a composite armament of protected and unprotected guns. This valuable suggestion has not received sufficient attention.

Armament inadequate in proportion to displacement.

Speaking generally, the armament of the most recent ships is not proportionate to their tonnage: the offensive power has been unduly sacrificed to the defensive, the gun to the armour. In a speech at the United Service Institution on March 30, 1870, Captain Dawson said:—

'In all the later ironclads there has been a continual diminution in the offensive power of the armament. We have an instance in

the "Devastation," a ship of 9,000 tons, carrying only 140 tons of ordnance. That is a very limited offensive power for any first-class ironclad. The 140 tons are divided into four untried pieces. If anything happens to any one of these four untried pieces, one quarter of the armament will be lost.' Mr. T. Brassey.

Captain Dawson considered that the chances of hitting at a target were as 1 in 10, and that they would be much less in firing in a naval engagement. The 'Inflexible,' of 11,000 tons, carries only 320 tons of ordnance. It is certain that a ship of such vast dimensions would be more fitted for naval warfare by the substitution of 200 tons of ordnance for an equal weight of armour. The 'Nelson' and 'Northampton,' of 7,630 tons, carry four 18-ton guns and eight 12-ton guns. M. Dislère speaks favourably of the designs of these ships, but considers that the guns should be of heavier calibre. An 18-ton gun is not powerful enough for an engagement with a first-class ironclad. On the other hand, he considers the displacement of 7,630 tons is too large for ships intended only for the protection of commerce.

The same observations are equally applicable to our largest unarmoured ships. The 'Shah' has only two guns capable of penetrating the 4-inch armour of the 'Huascar.' In a recent lecture at the Royal Engineers' Institute at Chatham, Captain Bridge has pointed out the necessity for a numerous supplemental flotilla to enable a fleet of ocean-going ironclads to reduce an important fortress. He reminds us that when the Federal fleet attacked Fort Fisher, in the harbour of Wilmington, on January 13, 14, and 15, 1864, over 50,000 shells were fired from the ships. If the fleet which we have stationed in the Sea of Marmora had been required to engage the shore-batteries in the Dardanelles or the Bosphorus, the deficiency of the squadron under Admiral Hornby in regard to the number of the guns would have made itself felt. The supply of ammunition to Her Majesty's ships is but 85 projectiles per gun on the broadside, and in no case more than 170 per gun. With a supply of ammunition so limited, it is obvious that very large reserves would be required.

Our shipbuilding policy may be tested in the most practical way by examining the composition of the fleet under Admiral Hornby, with reference to the service in which it has recently been employed. Such a comparison will, I venture to say, afford the most conclusive proof of the necessity for adding to our existing naval force the smaller classes of fighting vessels. While the splendid ships assembled under Admiral Hornby possess unquestionably great power for battle, they were mostly designed for ocean warfare, rather than Coast-defence vessels.

Mr. T. Brassey. for inland service. A deep draught of not less than from 26 to 27 feet is a serious drawback when operating along the shore. The Royal Commission on our coast defences laid it down that the maximum draught of a coast-defence vessel should not exceed 15 feet. How many ironclads do we possess drawing less than 15 feet? The coast-defence vessels, while less costly than the large ships, would have been better adapted to the practical exigencies of the naval service in the Mediterranean, the Red Sea, the Straits of Singapore, and in other confined waters where we have great interests at stake. It was for naval operations on the coast that the Americans invented the monitor. For 55,000*l.* Mr. Ericsson undertook, in the space of one hundred days, to construct an unarmoured shot proof coast-defence vessel, displacing 1,200 tons, drawing 10 feet of water, and capable of going 9 knots an hour. He kept his word. If such an achievement was possible in the United States in 1864, it encourages us to believe that the mechanical resources of the United Kingdom in 1878 would be capable of promptly creating a most powerful flotilla. I trust, however, that we shall not be betrayed, in reliance on our latest resources, into a policy of procrastination. Vessels, even small vessels, hurriedly constructed, must be imperfect in many ways; and hasty preparations for war, at a time when our foreign relations are becoming constrained and difficult, are necessarily irritating.

No Navy has had so much experience of coast warfare, since the introduction of armour, as the American. Their officers are unanimous in their approval of the monitor for engaging batteries. The type combines in the highest attainable degree the two qualities which Vice-Admiral Touchard considers most essential in a coast-defence vessel—namely, a maximum of invulnerability and a maximum of armament. Of the 30 monitors which the United States had afloat during the war, only one was destroyed by the fire of the enemy. The monitor, or armoured gunboat, is being rapidly introduced into European navies. The Germans have constructed two monitors, and five armoured gunboats of 900 tons displacement, protected by 4-inch armour and carrying one large gun. Of the 27 ironclads in the Russian Navy 22 are designed for coast defence; seven draw from 19 to 17 feet, one 14 feet, and 13 draw 11 feet and under. The latter are exact reproductions of the American types. The French have 35 ironclads afloat, and 16 in construction. Of their 51 ironclads, 19 are coast defenders. Six of the latter which are now in construction are of great power.

Another deficiency may be pointed out in our Mediterranean Fleet: our large ships are unsupported by a supplemental force of steam

rams and torpedo vessels. It is not necessary to insist on the offensive power of the torpedo. The House was sufficiently alarmed by the very able and stirring speech of the noble and gallant Member for Waterford (Lord Charles Beresford), whose devotion to his profession we must all admire. It must be obvious to those least familiar with naval matters that it would be extremely difficult for an ironclad, armed with a limited number of heavy guns, to repel the simultaneous attack of numerous torpedo-boats steaming at 20 knots, and manned by determined men. Several boats might be destroyed, but others would succeed, under cover of the smoke, in striking a fatal blow. In the Session of 1876, at the Institute of Naval Architects, Mr. Barnaby acknowledged the vulnerability of our largest and most powerful ironclads, if attacked with the ram and torpedo; and he pointed out, with the concurrence of Sir Spencer Robinson, that the strongest defence against such an attack was by a counter-attack with similar vessels attached to the large ships. Admiral Porter, in his Annual Report to the Secretary of the United States Navy, has returned again and again to this subject. In the year 1874 he asked for 50 iron torpedo-boats, of a moderate speed, and of not less than 100 tons each. He has since recommended that, besides several small torpedo-boats built for coast defence, six, of little more than 1,000 tons, should be constructed of iron for foreign service. The Americans have lately built a torpedo vessel, the 'Alarm,' of 100 feet in length, 28 feet in beam and 10 feet draught, which carries one heavy gun, eight Gatlings, and a complete torpedo gear. The programme for the German Navy provides for 28 torpedo vessels, which are to be completed in the year 1882. Admiral Porter considers that those 28 torpedo vessels will make the eleven ironclads which Germany already possesses a match for an equal number of ironclads of twice the size, without torpedo-boats. Torpedo-boats might be carried for the fleet in special vessels. Boats of this description have become a necessary part of the equipment of a fighting ship. In the German Navy, the 'Sachsen' class of armoured corvettes, of which it is proposed to build five, with a displacement of 7,300 tons, carry torpedo-boats of large size. The 'Duilio' is fitted with special appliances for launching torpedo-boats in a seaway. The Estimates which have been laid before us provide for the construction of 28 torpedo-boats in 1878–79. The number is greatly inferior to the flotilla which, according to common rumour, was lately being prepared for the Russian Navy.

Mr. T. Brassey.

Auxiliary vessels. Torpedo-boats.

Armoured vessels, possessing in a high degree the manœuvring qualities so essential in the ram, are another indispensable adjunct to

Auxiliary vessels. Rams.

Mr. T Brassey

a fleet of larger vessels. It was stated by the late First Lord of the Admiralty (Mr. Hunt), in moving the Estimates of last year, that it was in contemplation to build a ram on the plans of Sir George Sartorius. I regret that no progress has been made in carrying out that intention. The Hon. Member for Pembroke (Mr. E. J. Reed) has publicly stated that, in his opinion, before armour is superseded as a defence against guns, guns will be superseded as a means of attack; and the ship itself, viewed as a steam projectile, will be deemed the most formidable weapon. In the essay for which the gold medal of the United Service Institution was awarded, Captain Noel proposed that a group of three vessels should constitute the tactical unit of the Fleet. The group should consist of one third-class ironclad and two armoured rams of about 2,500 tons each. Our costliest and most heavily armoured ships are too large to be manœuvred as rams, and too costly to be risked in such an uncertain and hazardous mode of warfare. I cannot but view with regret the hesitation of the Admiralty to take in hand the construction of auxiliary vessels which are required to complete our Fleet. These small rams and torpedo-boats would have cost a mere fraction of the sums expended on the large ships, around which they ought at this moment to have been grouped in the narrow waters of the Sea of Marmora.

Special vessels for the ram, the gun, and the torpedo.

It has been said by Captain Colomb that we have no ship in our Navy in which the principle of building special vessels for special services has been satisfactorily embodied; we have no ship in which the gun-power has been properly sacrificed to assist the ram, or the ram-power judiciously curtailed to admit of increased ordnance. The general policy which should guide our naval construction was well described by Sir Spencer Robinson when he said: 'A fleet must be composed of ships of various classes. No single ship will be adapted for naval warfare with the means of destruction which now exist. Every ship must act in combination with other ships; she must be the unit around which other ships congregate: and when we have got the ship and her satellites in attendance upon her of the right size, sort, and stamp, then we have got the one unit of force capable of doing its duty in what may be called single action; and the concentration of those ships and their attendant satellites will constitute a fleet.'

The same views were expressed by Captain Vansittart. In his Report to the Admiral in command of the Channel Fleet in 1868, he said:—

'I recommend the construction of a certain number of turret-ships, capable of mounting far heavier guns than any known in the

late squadron, besides some few armoured rams, simply as rams; not with the idea of substituting turrets for broadsides, but with the view of strengthening England's fleets. In short, I would adopt the old saying of not putting all our eggs into one basket.' Mr. T. Brassey.

In the ship-building programme of the future, I hope to see the principle of special classification more distinctly recognised. This was the policy so strongly recommended by the Committee on Designs. As a powerful armament, thick armour, speed, and light draught, cannot be combined in one ship, although all are needed for the defence of the country, there is no alternative but to give the preponderance to each in its turn amongst the different classes of ship, which shall mutually supplement each other. The first-class battle ships of the future will doubtless be constructed after the type of the 'Devastation.' The large ships, again, must be supported by armoured rams, torpedo vessels, and torpedo-boats. For ocean warfare we require belted cruisers, of which the 'Nelson' and the 'Shannon' are our latest examples; for the protection of commerce we need small, lightly armoured vessels; for coast warfare, rams, monitors, and torpedo-boats. The proportions in which these several types are required is a question which the Committee recommended by my hon. friend would examine with great advantage.

Arguments for moderate dimensions for unarmoured ships.

Passing from the armoured vessels, I must express my regret that such large sums have been expended on unarmoured vessels, in no essential respect more powerful than the fine ocean steamers which can be hired in an emergency for naval service. Large unarmoured ships, such as the 'Shah,' 'Raleigh,' 'Iris,' and 'Mercury,' in which every other quality has been sacrificed for the sake of speed, and which, from their limited coal-carrrying capacity, are conspicuously inferior to the American liners in their power of maintaining that speed, give the least satisfactory result, in proportion to their cost, which has ever been obtained in any vessel built for war. In 1874, in one of his many able papers read before the Institution of Naval Architects, Mr. Barnaby stated the objections to large unarmoured ships in the strongest terms. He said—'The matter in which the naval architect is sometimes tempted to sacrifice the just balance of good qualities—reckoning moderate cost as one of them—is in aiming at too high a speed. He may be satisfied that a certain speed is a good working rate; but if a foreign Power has a ship possessing, or reputed to possess, ever so small an advance in point of speed, there are always people ready to insist on the enormous superiority of even a slight excess in speed.' If the policy of building such vessels had been deliberately examined by such a Committee

Mr. T. Brassey.

as my hon. friend proposes, I cannot believe that it would have been approved. Here I may congratulate the Admiralty on the disappearance of the 'Raleigh' type from the programme of the present year, and on the concentration of expenditure on fighting vessels not to be hired from the Mercantile Marine. A comparison of the present shipbuilding programme with that of former years shows the following result:—

	Armoured	Unarmoured	Total
	Tons	Tons	Tons
1870–71	7,490	7,742	15,232
1878–79	9,831	3,737	13,568

Armour necessary for vital places.

Every ship which is specially constructed for naval warfare should be protected by a certain amount of armour. The effect of a single chance shot on an unprotected vessel was sufficiently shown in the action between the 'Alabama' and the 'Kearsage,' and, in the Franco-Prussian war, in the action between the 'Meteor' and the 'Bouvet.' The Americans protected the machinery of their vessels by using the cable as a temporary chain armour. By a slight reduction in the length and a moderate increase in the beam, sufficient floating power would be gained to enable our larger unarmoured cruisers to carry a light belt of armour at the water-line, which would materially strengthen the bow for ramming, and protect the machinery and the boilers. The hon. Member for Pembroke has shown how this can be done practically in the three belted cruisers which he has recently built for the Japanese Government. We have not enough ships in our Navy corresponding to the useful class which have been recently built in our private yards for the Government of Japan. These observations on the designs of some of our most recent ships will, I venture to think, be sufficient to justify the proposed inquiry.

Constructive council desirable at the Admiralty.

Let us now examine the system adopted for carrying those designs into execution. I may here be allowed to remark that, so far as I have any means of judging, the present Controller and Chief Constructor, and the officers under them, deserve well of their country. Their mistakes have been few, and they have achieved many remarkable successes. But the present organisation does not give to the Navy the full benefit of all the professional and naval experience which this country possesses. The administration is conceived on too narrow and exclusive a basis. It is too much concentrated in one or two individuals. The Constructive Department of the Admiralty is overtasked, and ought to be strengthened. The adminis-

trative, consultative, and scientific functions should not be combined in one hand; the same individuals ought not to propose designs and afterwards pass them in review. In France a large Council of Advice has been employed, and the shipbuilding policy has been settled in accordance with a programme, revised from time to time, but requiring a long period of years for its execution. In this country I should deprecate the adoption of a similar course; but if a council has been found necessary where several ships have been built from each approved design, how much more must it be required where the same design is never repeated? It was suggested by the Royal Commission on Scientific Instruction that a Council of Advice should be appointed by the Government. The evidence collected with reference to the Controller's Department of the Admiralty clearly showed that the present staff were too much absorbed in their administrative duties to be able to give a due proportion of time and thought to original investigation. The recommendations of the Royal Commission on Scientific Instruction were based on the evidence of such men as Mr. Froude, Sir William Thompson, Mr. Anderson, the Superintendent of Machinery at Woolwich, and the hon. Member for Pembroke. Mr. Froude told the Committee that if such a Council had existed, enormous sums would have been saved, which had been expended in the construction of ships on a scale of twelve inches to the foot. The incompleteness of the preliminary investigations has led not only to defective designs, but to wasteful expenditure and long delay. Sir Spencer Robinson repeatedly remonstrated against the alterations of the 'Devastation' during the period of construction. They led to the inevitable consequence of delaying by one year the completion of the ship. The draught of water was increased to such an extent that the upper edge of the plating at the bow is actually below the water-line. The same delay occurred in the case of the 'Dreadnought,' which was commenced in February 1870, launched on March 8, 1875, and is not yet completed. The estimates for this ship have been steadily increasing. The estimated cost was 269,000*l.* in 1870; it has since advanced by rapid strides to 451,000*l.* The same thing happened in Russia, where the 'Peter the Great' was commenced in 1869 and only completed in 1877. The most recent cases seem quite as grave as those quoted by Lord Clarence Paget before the Dockyard Commission in 1860, and they demand the same remedy which he proposed. He said:—

Mr. T. Brassey.

'The "Immortalité" was lengthened forwards, amidships, and abaft, and having been so lengthened, her bow was again pulled

Lord Clarence Paget.

Mr. T. Brassey. down and lengthened. If such a thing were to take place in a private yard, it would be considered a very unbusiness like way of conducting operations. I am of opinion that if a fair consideration had been given to the subject of her lines—if it had been discussed, for instance, in a committee of scientific men—the necessity of lengthening her during building would have been obviated.'

The waste of public money through repeated modifications of a design during construction was denounced, with his usual force, by Mr. Cobden, in his well-known pamphlet on the *Three Panics*. These remonstrances are equally needed at the present time.

Mr. Cobden.

Commission on scientific instruction.

Sir William Thompson told the Commission on Scientific Instruction that a Scientific Council would have prevented the loss of the 'Captain.' Mr. Anderson, who has been responsible for the expenditure of very nearly 3,000,000*l.* of the public money, assured the Commissioners that with a systematic investigation great improvements could be introduced. In the Government service, everybody who gets any work to do worth mentioning is overpowered with work, and has too little time for deliberation and reflection. The Naval Lords cannot possibly have the leisure to consider thoroughly the numerous questions of naval architecture, tactics, and organisation which constantly present themselves. They should be relieved of much of the detail which now occupies their time, by the appointment of a Captain in the Navy to act as their Secretary, or *chef de bureau*. Such a Council as was recommended by the Royal Commission should, for Admiralty purposes, be composed of officers who have recently served afloat, especially in fleets composed of ironclads, and should include officers who have recently served at the Admiralty. The advice of an ex-Controller could never be without value to his successor. The members of the Council should be appointed for limited periods, and should be regarded solely as advisers to the minister, who would retain, as now, his sole responsibility to Parliament. Nothing could more conclusively prove that the Constructor's Department is not strong enough for the work which it has to do, than the slow progress in the completion of designs for new ships which is indicated in the Estimates we are about to consider. Three years have elapsed since a new ironclad was laid down in Her Majesty's dockyards; and yet that interval, regrettably long as it has been, has not been sufficient to enable the Constructor's Department to determine the types of any one of the ironclads it is proposed to commence in the ensuing financial year. All the ironclads now in course of construction in the dockyards were included in the programme of 1875–76.

Mr. T. Brassey.

French Conseil de Construction.

I have already alluded to the Council of Advice, which is permanently in session at the French Admiralty in Paris, and in which all the civil departments, and all branches of the naval profession, are represented. In the French service the Constructor's staff is materially strengthened by appointing officers to the dockyards, possessed of the highest scientific attainments and capable of preparing independent designs for ships of war. It is the practice of the Council of Construction in Paris to fix on the type of ship required for a particular service, and having stated the various qualifications to be embodied in the new designs, competition is then invited from the different dockyards. There can be no reason why designs should not occasionally be obtained from independent members of the profession of naval architecture. This was done in 1867, by means of a circular letter, issued by Lord Henry Lennox.

Skill in private shipbuilding yards.

In the recent purchases by the Admiralty, we have remarkable illustrations of the ability of the private constructors of this country. The 'Superb' is an improved 'Hercules,' and the 'Belleisle,' with 600 tons less displacement, is superior to the 'Hotspur' and 'Rupert.' It would be unjust to the Controller's Department to forget that they have been equally progressive in their new designs: but I again, and for the last time, complain that too little attention has been given of late years to the smaller types.

Observations on naval expenditure of England

The Naval Estimates at the present time are not sufficient to provide for all the requirements of the Navy. It is the policy of this country to keep up a larger *personnel* for the Navy than that maintained by any other of the Continental Powers. Hence it is that while in Germany 66, in Russia 62, and in Austria 48 per cent. of the naval expenditure is devoted to construction, the corresponding figure in England is only 36 per cent. Further, we maintain an extensive unarmoured fleet for the protection of trade. We have 313 unarmoured to 54 armoured ships; France has only 109 to 48; Germany 58 to 20; and Italy 49 unarmoured to 17 armoured ships The maintenance of our large unarmoured fleet for the protection of a trade—the profits, but not the burdens, of which are shared with other countries—goes far to explain the necessity for a temporary increase in our appropriations for shipbuilding. In considering our shipbuilding policy, the Committee proposed by my hon. friend would necessarily be called upon to inquire as to the sufficiency of the present Naval Estimates. Deducting the non-effective vote, the sum available is 8,900,000*l*., of which 3,500,000*l*. sterling are expended in the dockyards. The corresponding figures for the French Navy are 2,800,000*l*. The German Estimates include 520,000*l*. for

Mr. T. Brassey.

the maintenance of the fleet, and 1,720,000*l.* for building the ships ordered in the programme of 1872. If, therefore, we compare the naval expenditure of the three countries with the 6,000,000 of tonnage belonging to the United Kingdom, or more properly the 8,000,000 tons belonging to the British Empire, and the 1,000,000 tons sailing under the French and German flags respectively, we shall find that the expenditure of the French Naval Department far exceeds our own. If France had not been temporarily crippled by the German War, we should have been in a very decided state of inferiority in armoured vessels; and this notwithstanding the vastly greater interests we have at stake.

Defence of colonies.

We have as yet done nothing for the defence of our Colonial possessions by the creation of those centres of naval power to which the Committee on Designs directed attention as the most effective means of affording naval protection to our Colonial trade. The resources of the dockyards having been wisely developed during the past two years to putting the fleet in repair, shipbuilding has in consequence made but slow progress. The better plan would be to consider the whole question of the defences of our foreign trade and Colonial harbours, and to vote a lump sum for carrying out their recommendations.

We ought to make the same provision for bringing up our arrears of shipbuilding which was granted on a former occasion for the defence of our dockyards at home. The programmes of naval construction adopted in France in 1872, and in Germany in 1873, have been carried out in each case by means of a special credit voted annually in addition to the ordinary provisions for the maintenance of the Navy.

General confidence in Admiralty administration.

Returning to the proposal of my hon. friend for the appointment of a Committee on the designs of our ships of war, I do not know what course the Government may take. We do not intend to imply a want of confidence in the First Lord of the Admiralty, whose advancement to his high office was received with such hearty approval on all sides. It cannot, however, be disputed that his onerous administrative duties leave scanty leisure to him and his naval advisers to mature designs for new ships. Numerous Royal Commissions and Departmental and Parliamentary Committees have from time to time been appointed on naval business. Their labours have not been unfruitful. There has been no unworthy jealousy of external advice. In foreign countries abundant precedents can be quoted of a similar character. In France many Committees of Inquiry into the Navy have from time to time been appointed. The

Annual Commission on the Naval Estimates bears a close analogy to the Committee now proposed. The French Commission of the present year included MM. Gambettà, Waddington, and other well-known statesmen; and the report by M. Bethmont, embracing the whole subject of Naval Administration and throwing a flood of light on many of the most difficult problems of the time, is just such a report as I should hope might be presented by a Committee of this House. I conclude, as I began, by expressing my intimate conviction that, while our administration still leaves something to be desired, the Navy is in a sound and wholesome state, and was never relatively so powerful as it is at the present time.

Mr. T. Brassey.

THE FLEET IN THE MEDITERRANEAN.

Mr. T. Brassey.

Remarks on the *personnel* of the Navy. From Hansard's 'Parliamentary Debates,' vol. ccxliv.

Before entering upon other topics, an agreeable task devolves on all who take an interest in the Navy. The Navy deserves the acknowledgments of the country for the many proofs of its efficiency which have been afforded during the past year.

The condition of the Coastguard was tested, with highly satisfactory results, in the special-service squadron under Admiral Key. The duty, undertaken by Lord John Hay's squadron, of landing a numerous army and 40,000 tons of stores, under the burning sun of Cyprus, was most laborious, and it was cheerfully performed. The men worked from four in the morning till seven in the evening under the personal command of the Duke of Edinburgh, and they worked without a murmur.

During a recent cruise in the Mediterranean, I was repeatedly in contact with the Navy, and it was evident, even to the eye of a civilian, that every officer and man under Admiral Hornby's command was determined to do and dare anything that the country might require of him. I know not whether to admire most the fighting spirit which animated the fleet, or the excellent discipline, by which that spirit was kept under control, during the long, anxious, and weary period of expectation which the fleet had passed in the Sea of Marmora.

Pay of the Navy.

The debate on Vote I. affords a convenient opportunity for discussing the important question of the pay of the Navy. That question has been raised in the House in former years, in able speeches, by the noble and gallant lord the Member for Waterford, and by the hon. Member for Reading.

The pay of the able seaman in the Navy is 1*s*. 2*d*. per day. Recently an additional 2*d*. per day has been given to all continuous-service men, on re-engaging after ten years' service. The average pay of seamen of the mercantile marine in the ports of the United States varies from 6*l*. to 8*l*. per month. On the Australian station the average wages are on a still higher scale. The Royal Navy un-

doubtedly offers many advantages over the merchant service, not the least considerable being the prospect of a pension. The young seaman, however, attaches little value to a prospective benefit. Captain Wilson, the Commodore on the Australian station, has estimated the annual loss, by desertion, at 500 men, and the average cost of training an able seaman at from 300*l.* to 400*l.* Commodore Wilson proposed to increase each man's pay every five years by 2*d.* a day, or 3*l.* a year, whatever his rating might be, provided it was not below that of A.B., and by 3*d.* a day for each rating above that of A.B. The proposed increase of pay might be limited to seagoing ships, perhaps even to vessels serving on certain foreign stations. Married men lose money when serving in a sea-going ship, and the best conducted men are always scheming to serve in harbour-ships. *Mr. T. Brassey.*

The extra pay to the army in India, and the extra premiums on policies of insurance exacted from officers on foreign stations, afford a strong argument for a higher rate of pay to the seamen of the Navy when serving abroad. Desertion is comparatively rare in the home ports, in the Mediterranean, and on the China and East Indian stations. In other parts of the globe, it is a source of deep anxiety and mortification to the officers in command of Her Majesty's ships. When I was in the River Plate, in 1876, I went on board a gunboat, which had just received a batch of young ordinary seamen from England. On the morning after their arrival, three of these young men deserted, causing a loss to the country of at least 1,000*l.*

The subject has been repeatedly urged upon my attention by naval officers whom I have met abroad, and I have lately received a long and able letter on the subject from a distinguished admiral, whose flag is now flying in a foreign station, where the Navy is particularly liable to suffer from desertion.

Defects in 'Glatton' and 'Gorgon' class.

Turning from the *personnel* to the *matériel* of the Navy, two great fleets have been assembled during the past year—the special-service squadron under Admiral Key, and the fleet under Admiral Hornby. In the squadron under Admiral Key, the coast-defence vessels are a characteristic feature. The 'Glatton' and the four vessels of the 'Gorgon' class have been severely criticised in the debates at the United Service Institution. It has been truly said, that they are not seaworthy, and no vessels can be accepted as effective for the defence of the stormy coasts of Great Britain unless they are absolutely seaworthy. The defects of the 'Gorgon' class, and the comparatively inexpensive means by which those defects may be remedied, were pointed out by Admiral Ryder in the course of the

Mr. T. Brassey. discussion at the United Service Institution. He remarked that, as regards the 'Gorgon' class, the Committee on Designs had condemned these vessels as sea-goers. Their unanimous report was that if a certain superstructure extending along a good portion of each vessel's side was not put on, they could be depended upon to go from port to port with safety only in fine weather. That, said Admiral Ryder, was a very startling statement to make about ships of war. And yet the superstructure referred to has not yet been put on, although five years have elapsed since the suggestion was made. I scarcely dare to offer an opinion of my own on such a subject; but the necessity and feasibility of the proposed alteration must be patent to eyes which have any familiarity whatever with naval structures. With the superstructure, the 'Gorgon' class would present a similar appearance, of course on a reduced scale, to the 'Dreadnought'—at present perhaps the most satisfactory type of battle-ship in the British Navy, while their buoyancy and stability would have been so much improved, that they might have been sent out with confidence to reinforce the squadron under Admiral Hornby. Their suitability for operations in the Dardanelles and the Bosphorus cannot be disputed. Our noble ironclads in the Sea of Marmora were designed for ocean service, for which their high freeboard is especially adapted. We want such vessels, but we also require a flotilla of the American monitor type for coast-defence and coast-attack.

French ironclads in construction. I now invite the Committee to look for a few moments at the work in progress in foreign dockyards. The only navies for which ironclads are at present in course of construction are those of France, Germany, Italy, and the United States. The Germans are building three ships of the 'Sachsen' type, of 7,398 tons, protected by 10-inch armour, and carrying their guns in fixed turrets on the upper deck. These ships can be completed in two years. They are also building four armoured gunboats of 1,000 tons, with 8-inch armour. The French are building a turret-ship of the 'Duperré' type, of 10,000 tons, with 22-inch armour; two central battery ships of the 'Foudroyant' type, of 9,608 tons, with 15-inch armour; three armoured corvettes of the 'Bayard' type, of 5,880 tons, with 10-inch armour; two coast-defence vessels of the 'Tonnerre' type, of 5,500 tons, with 13-inch armour; and two rather smaller ships of the same class, of 4,524 tons. The corvettes have been lately commenced; the other vessels can be completed in about two years. The United States have five monitors building—the 'Puritan,' of 5,300 tons, with 11 inches of solid armour; the 'Miantonomah,' of 4,000 tons, with

Mr. T. Brassey.

United States.

11 inches of laminated and 5 inches of solid armour; the 'Monadnock' and 'Terror,' of 3,600 tons; and the 'Amphitrite,' of 2,800 tons, with inferior armour protection. The Italians have in completion their two well-known ships, the 'Dandolo' and the 'Duilio.' The 'Lepanto' and the 'Italia,' each of 14,000 tons, are on the stocks.

A list of the armoured ships in construction, which I have compiled from the best published sources of information, shows a total of 27,000 tons for the German Navy, about the same for the Italian, 67,000 tons for the French, and 19,300 tons for the United States, against 53,000 tons for the British Navy. Of tons displacement we are to build during the ensuing financial year about 11,000 tons. The French construction for the same period I estimate at 9,000 tons, the German and Italian at 5,500 tons, and that of the United States at 4,000 tons.

Insufficiency of Naval Estimates.

On the whole, I consider the proposal of the Government as not inadequate, having in view the additions to the armoured fleet by purchases from the vote of credit. I regret, however, the dismissal of good workmen from the dockyards, and believe that the present reduced numbers must hereafter be increased. The fluctuations in the numbers employed not only inflict great inconvenience on the workmen, but involve expense to the country. You cannot expect to obtain labour so cheaply for a temporary as for a permanent employment. Considering the vast and growing importance of our colonial empire, the extent of our shipping, and the dependence of a large portion of our population on imported food, and looking also to the naval force maintained by other Powers, to whom a navy is an object rather of national vanity than of necessity, I venture to say that an annual expenditure of 12,000,000*l.* would not be an exaggerated charge for the British Navy. When we contrast the relative importance and cost of the Navy and the Army, it would seem that it is to the land service rather than to the Navy that the pruning knife should be applied.

Italian naval construction.

I will not trouble the Committee further as to the progress of construction, and will now proceed to say a few words on our shipbuilding policy generally. It is only in Italy that designs of colossal dimensions have been adopted, and even there they are approved by a small section only among the officers of the Navy. I owe the privilege of seeing the 'Italia,' now in course of construction at Castellamare, to the great kindness of my right honourable friend the First Lord of the Admiralty.

Argument for moderate dimensions.

It is not at present in contemplation to follow the Italian constructors in building ships of extended dimensions; but public

Mr. T. Brassey. opinion, always so susceptible on the question of our naval supremacy, may perhaps hereafter exert a pressure in that direction. It may not, therefore, be superfluous to state the arguments against the introduction of ships like the 'Italia' into our own Navy. There is much to admire in the details of the 'Italia,' but considering that the abandonment of side armour is an essential feature in the construction of that vessel, and that the great dimensions of the 'Inflexible' class have been adopted, with all their attendant disadvantages, solely with the view of carrying an increased weight of armour on the sides, I cannot think that the Italians are wise in building so large a ship. It has been attempted to defend the design on the ground that it insures an invaluable superiority in regard to coal-endurance. Let us follow up the argument. It is admitted that ships of 9,000 tons can be built, capable of attaining the same speed as the 'Italia,' and possessing a marked superiority in evolutionary qualities. When the ram is resorted to, the battle will be decided in favour of the fleet which has a preponderating advantage in point of numbers. The more numerous ships, it may be assumed, will be as superior in evolutionary qualities as in numbers. With an equal expenditure, an unquestionable superiority for battle would be attained with ships of the 'Colossus' and 'Agamemnon' type, as compared with the 'Italia.' But it is argued that the 'Italia,' having the advantage in point of coal-endurance, would decline battle, steam away from the smaller ships, bombard our undefended ports, and intercept our commerce. The *rôle* of the 'Italia' is therefore to be that of the 'Alabama'; but while the former will cost three-quarters of a million sterling, the latter was probably built for one-twentieth of that amount.

Captain Colomb. In regard to the general policy of naval construction, Captain Colomb, the gifted author of the Prize Essay of the United Service Institution, has made the following observations: 'Looking to the fleet as a moveable force, the main object should be to have, to the greatest possible extent, the power of concentration and the power of dispersion. The policy of marine construction must be based on this primary strategical principle. Applying this principle to the individual ship the "Inflexible," it may be asked, does such an accumulation of expenditure on a single vessel represent the greatest power of concentration and dispersion over the area within which our naval forces are to act?' Viewed in this way, and assuming that the object of strategy is to ensure the right force being at the right time in the right place, Captain Colomb would, as a matter of sound policy, increase the number of ships rather than attempt to gain tactical

results satisfactorily in one ship by the sacrifice of strategical qualities. *Mr. T. Brassey*

I rejoice that these principles have prevailed in the latest decisions of the Admiralty in respect to shipbuilding. The four largest ships now building are under 9,100 tons, and the 'Conqueror' seems to be designed especially to meet the suggestion put forth by Mr. King, the chief engineer of the United States Navy. In his report on the ironclads of the European navies, he concludes the description of the 'Inflexible' with a suggestion that two vessels of smaller dimensions, each carrying two 80-ton guns instead of four, would probably have been a safer and in some respects a better investment. We have an excellent example of the fighting power which can be obtained, within comparatively narrow limits as to tonnage, in the 'Belleisle' and the 'Orion,' built by Messrs. Samuda for the Turkish Government, and purchased out of the vote of credit. These ships would have been an invaluable adjunct to the squadron in the Sea of Marmora.

The advocates of moderate dimensions do not desire to cut down the Estimates; but they wish to divide the risk of naval warfare, to increase the evolutionary qualities of our ships with a view to the use of the ram, and to secure to the Royal Navy the essential advantage of numbers.

INDEX.

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